The Governance of Risk Management: The Importance of Directors' Independence and Financial Knowledge

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Abstract

This paper tests the effects of the independence and financial knowledge of directors on risk management and firm value in the gold mining industry. Our original hand-collected database on directors' financial education, accounting background, and financial experience allows us to test the effect of each dimension of financial knowledge on risk management activities. We show that directors' financial knowledge increases firm value through the risk management channel. This effect is strengthened by the independence of the directors on the board and on the audit committee. Extending the dimension of education, we show that, following unexpected shocks to gold prices, educated hedgers are more effective than average hedgers in the industry. As a policy implication, our results suggest adding the experience and education dimensions to the 2002 Sarbanes–Oxley Act and New York Stock Exchange requirements for financial literacy.

Keywords: Risk management governance, hedging, financial knowledge, financial literacy, financial and accounting education of director, financial experience of director, independence of director, policy implications.

JEL Classification: D83, G14, G18, G28, G30, G32, G34, G38

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"Risk comes from not knowing what you're doing" —Warren Buffett.

Despite the regulatory attention given to corporate governance through the rules set by the Sarbanes–Oxley Act (SOX) and the New York Stock Exchange (NYSE) in 2002, a recent report of the Economic Co-operation and Development (OECD) attributes the 2007 financial crisis to the failure of the boards in overseeing risk management systems,[1] the reason often being the board's limited knowledge and understanding of the risks involved when using complex financial assets:

In dealing with losses through to the end of 2007, the report noted that some firms made strategic decisions to retain large exposures to super senior tranches of collateralized debt obligations that far exceeded the firms understanding of the risks inherent in such instruments, and failed to take appropriate steps to control or mitigate those risks ...In a number of cases boards were not aware of such strategic decisions and had not put control mechanisms in place to oversee their risk appetite, a board responsibility. (Kirkpatrick, 2009, p. 7)

The report points to the failure of the board of the Union Bank of Switzerland in assessing the total derivative portfolio exposure of the bank, leading to a loss of USD 18.7 billion during the fourth quarter of 2007. Later, in France, a junior trader at Société Générale successfully managed to camouflage his transactions with derivatives, leading one to believe that they were indeed hedging positions when, in fact, they were speculative positions. Of course, the board of directors did not suspect the fraudulent nature of these transactions nor did it recognize the increase in the bank's uncovered position until the historical loss of 4.9 billion euros was realized in 2008. Similarly, in the United States, the weakness of boards' financial knowledge contributed to deepening the financial crisis and induced large losses to public authorities while trying to restore the financial system.

The OECD report does not limit the importance of qualified board oversight or the need for robust risk management to financial institutions. (Kirkpatrick, 2009, p. 2). Drawing lessons from the 2007 crisis, the report emphasizes the necessity of certifying a minimum level of financial knowledge for the directors on boards and those composing the audit committees to ensure that they understand issues related to risk exposure and risk management. From a policy standpoint, it appears that the 2002 requirements of the independence of board directors and audit committees, as well as financial literacy requirements, were not sufficient to achieve the efficient governance of risk management policy, practice, and control.[2]

[1]We are aware that other exchanges amended rules to regulate corporate governance in their listed firms, but we refer to the NYSE as being the largest US stock exchange, with more money at stake, with NYSE market capitalization around $16.6 trillion in 2014 compared to $8.5 trillion for NASDAQ.

[2]Section 301 of the SOX requires that "each member of the audit committee of the issuer shall be a member of the board of directors of the issuer, and shall otherwise be independent." Section 407 requires that "the

market-to-book financial literacy is required by current SOX and NYSE regulations for members of the audit committee, it is not required for the other members of the board. Moreover, there is ambiguity regarding the need and the definition of a financial expert on the audit committee, even if this committee is responsible in overseeing the firm's financial risks according to NYSE rules. Under current regulation, financial literacy does not necessarily mean financial expertise (financial education and experience). The qualification of financial literacy under the rules is open to interpretation by the company's board itself. In addition, directors who do not meet this requirement must become financially literate within a reasonable yet undefined period following their appointment to the audit committee. SOX rules require each regulated firm to disclose whether the audit committee comprises at least one financial expert. If not, the company must explain why. These rules leave room for interpretation and may not be effective.[3]

Our goal is to explore different dimensions of financial knowledge and test whether they add value to the firm through the channel of risk management activities. Given the importance regulators have given to directors' independence, we also address the benefit of independent directors on the board or the audit committee and whether this requirement adds to firm value.[4]

We first break down the definition of the financial literacy of directors into three categories. A director has a financial knowledge if he or she is i) financially active or has financial experience, ii) is financially educated, or iii) possesses an accounting background. A financially active director should have some experience in the financial environment, such as having current or past activities/positions linked to finance (e.g., present or former chief financial officer, insurer, financial analyst, financial consultant, trader, banker, risk

commission shall issue rules...to require each issuer, together with periodic reports...to disclose whether or not, and if not, the reasons therefore, the audit committee of that issuer is comprised of at least one member who is a financial expert." The rules set by the NYSE define additional conditions concerning the independence of the board of directors and the composition of the audit, compensation, and governance committees. Specifically, Section 303A.01 of the NYSE's listed company manual states that "listed companies must have a majority of independent directors." Section 303A.04 states that "listed companies must have a nominating/corporate governance committee composed entirely of independent directors," while Section 303A.05 requires that "listed companies must have a compensation committee composed entirely of independent directors." Finally, Section 303A.07 states that the audit committee must have a minimum of three members. Each member of the audit committee must be financially literate; as such qualification is interpreted by the company's board in its business judgment, or must become financially literate within a reasonable period of time after his or her appointment to the audit committee. In addition, at least one member of the audit committee must have accounting or related financial management expertise, as the company's board interprets such qualification in its business judgment. In addition, Section 303.07 (D) of the NYSE's listed company manual requires the audit committee "to discuss policies with respect to risk assessment and risk management." Consequently, the audit committee (the board in general) is henceforth responsible for the firm's risk management policy.

[3]Although some regulations ask for the creation of a risk committee to monitor the risk management activities of large financial institutions, we consider that the monitoring of risk management activities is the responsibility of the audit committee, since our sample of firms comprises only public nonfinancial firms.

[4]Note that financial knowledge and financial literacy are used interchangeably in public and academic documents. Thus, we do not distinguish between these two terms and assume they are synonyms.

manager). A director is considered financially educated if his or her background includes a financial education (e.g., MBA, BBA, BCom). A director is considered an accountant if he or she has an accounting degree (e.g., CA, CPA), in accordance with the NYSE view. Our paper is the first to consider that directors can have financial knowledge due to their education. Besides the argument that the board members are responsible for the firm's risk management policy and, consequently, that any change in board composition or in the background of its members could affect board decisions in this matter, it is important to evaluate the effect of these qualifications on risk management policy and firm value for two additional reasons.

First, risk management implies dealing with derivatives and other sophisticated financial assets. A misunderstanding of these financial instruments may be extremely costly to the firm and its shareholders. By examining the effect of the financial knowledge of the board and the audit committee on hedging, we introduce a new set of explanatory variables that have never been tested in the literature as determinants of the firm's risk management behavior. We also address the previously unexplored question of whether a more financially qualified board and audit committee are beneficial to shareholders through the risk management channel.

The financial literature provides vidence suggesting that risk management reduces the firm cost of risk in imperfect markets and thus should be beneficial to shareholders. For instance, risk management can reduce tax payments (Smith and Stulz, 1985; Graham and Rodgers, 2002), financial distress costs (Stulz, 1984), information asymmetry costs (Stulz, 1990; DeMarzo and Duffie, 1991; Breeden and Viswanathan, 1998), investment financing costs (Froot, Scharfstein, and Stein, 1993; Morellec and Smith, 2002), external financing costs (Campello, Lin, Ma, and Zhou, 2011), and managers' risk aversion costs (Tufano, 1996). Therefore, a firm comprising financially knowledgeable directors capable of dynamically hedging the firm's exposure to risk should increase its performance. Several papers address the relation between risk management and the market value of the firm but they disagree on the direction of this relation. Jin and Jorion (2006) show that hedging does not increase firm value, while Allayannis and Weston (2001), Carter, Rogers, and Simkins (2006), Hoyt and Liebenger (2011), and Adam and Fernando (2006) obtain an opposite result. Campello, Lin, Ma, and Zhou (2011) find risk management eases the investment process, which can also increase firm value. Using appropriate instruments, we use two-stage estimation models to test whether the predicted level of hedging increases firm value as measured by return on equity, return on assets, Tobin's Q, and the market-to-book. We also test these effects using systems of simultaneous equations to address potential endogeneity between dependent and independent variables.

We use a very unique dataset comprising detailed information on corporate hedging activities in the gold mining industry and detailed information about the financial knowl-

edge of each director on the boards and audit committees included in our sample. The data on detailed hedging activities were obtained from the same source as the data of Tufano (1996) and Adam and Fernando (2006).[5]

Based on the observed hedging activities, we construct quarterly hedge ratios for each company during the period of the study. An important feature of our data is the fact that our sample covers the period preceding major corporate governance problems (e.g., Enron, WorldCom) and the preparatory work that led to the 2003 enforcement of the changes in corporate governance regulation. Therefore, the observed structures of the boards and audit committees in our sample of firms do not reflect changes made to comply with these regulations. They were freely determined by the firms.

Second, our data provide an independent yet unique assessment of the benefits of different private governance rules on risk management activities in addition to those observed in the 2002 regulations. Gold mining firms share a common exposure to the risk of changes in the gold price. Adam (2009) shows that most gold mining firms use options to hedge gold prices during our period of analysis. Given the multiplicity of hedging instruments available as well as this commodity's high level of liquidity, the risk of fluctuation of the gold price must be adequately managed. Thus, what should make the difference between different hedging positions in this particular industry likely reflects differences in firm characteristics, including the level of directors' financial knowledge and independence. By addressing the effect of directors' financial knowledge on hedging, we also verify the effectiveness of this requirement for hedging activities in this sector. Another important feature of our data lies in the benefits of having detailed information about the financial university education and financial experience of directors carefully hand-collected from various sources listed in Appendix C. Our data allow us to explore the diversity of directors' backgrounds in the financial sector and test the distinct effects of financial education and experience on firm hedging behavior.

This paper is closely related to those of Tufano (1996) and Adam (2009). Tufano (1996) uses the same source of data over a three-year time horizon (1990 to 1993) and explores the determinants of risk management activities. The author particularly looks at firm-specific data such as production cash costs, leverage, exploration activities, acquisitions, tax loss carryforwards, firm size, gold reserves, managerial stock ownership and option holdings, large block holdings, liquidity, and a measure of diversification. The results document a relation between variables related to managerial risk attitude and risk management behavior. However, Tufano questions whether costly corporate resources attributed to firm risk management activities are in fact devoted to firm value maximization or to managers' private risk taking. Unfortunately, the author does not test for this empirical question due

[5]Data on hedging activities were gracefully provided to us by Ted Reeve, a Canadian analyst who used to cover firms for Scotia Capital between 1989 and 1999.

to lack of data, although a more careful examination of the hypothesis is called for. We address this question in the robustness section of this paper. Specifically, we confirm Tufano's empirical results regarding the effect of officers' option holdings on risk management. We also show that part of the officers' risk management choices may be due to their own risk taking benefits, which raises another governance issue.

We also add to this study by directly testing the impact of directors' financial knowledge on the risk management activity of the firm after controlling for all other firm-specific variables mentioned above, including managers' risk aversion and other corporate governance variables. Adam (2009) considers the same sample of data that we use in this study. However, instead of studying the level of risk management, the author looks at the types of risk management activities. Adam shows that most gold mining firms hedge downside risk with options. Since the management, monitoring, and control of options and other derivatives require a minimum knowledge of these instruments, consideration of directors' financial knowledge will enhance our understanding of firms' differences in risk management.

We show how financial knowledge—education, experience, and accounting background—affects the risk management channel through which corporate governance mechanisms, including independence, become more effective to increase firm value. Our empirical evidence also highlights the importance of directors' university education and suggests that independent financially qualified members of the board and audit committee encourage hedging activities using derivatives. Most interestingly, we find that educated hedgers are more prompt in adjusting firms' hedge ratios following shocks in gold prices than the average hedgers in the industry are.

Exploring the link between risk management behavior and directors' financial sophistication has important policy implications. Specifically, we construct a compliance index that accounts for each of the SOX and NYSE requirements. We then test whether the value of firms compliant with one or all of these rules increases through better risk management. Our results suggest that compliance with SOX affects risk management activity but, generally, compliance with NYSE regulation does not affect it. This suggests that having independent members and at least one educated member on the audit committee is beneficial to risk management policy. However, these results are not fully satisfactory in the sense that compliance with the two regulations does not strongly affect firm value through the risk management channel.

We extend the analysis and construct a governance index accounting for independence, the three dimensions of financial knowledge (education, experience, accounting background), and the chief executive officer (CEO)–board relationship. Our index has broader coverage than the above compliance indexes and places more emphasis on the quality of the directors on the boards and audit committees, measured by the degree of their financial sophistication as well as their independence. Our results strongly support the idea that sound

corporate governance increases firm value. In our particular case, risk management is the channel through which corporate governance becomes effective and increases firm value.

The reminder of the paper is organized as follows. Section 1 documents the related literature and sketches the testable hypothesis. Section 2 describes our sample construction and variable definitions. Section 3 motivates our empirical approach and presents our research design. Section 4 delineates our analysis and results. Section 5 discusses the policy implications of our contribution. Section 6 presents our robustness analysis. We then conclude the paper in Section 7.

1 Literature and testable hypothesis

1.1 The board as a corporate governance mechanism

The board of directors plays a central role in any corporate governance system and is viewed as a primary means for shareholders to exercise control over top management (Kose and Senbet, 1998; Tirole, 2006). Specifically, board composition, independence, and engagement are key features in enhancing a firm's corporate governance system and achieving its performance goals. For instance, Armstrong, Core, and Guay (2014) show how the structure of a board dominated by related directors increases both the level of information asymmetry between shareholders and top management and uncertainty about firm value. A board structure dominated by independent directors has the opposite effect and leads to an increase in firm transparency and an increase in firm value. Falato, Kadyrzhanova, and Lel (2014) show how shocks in the workload of directors can affect firm value. Sudden changes in board structure can have negative impacts on firm value, especially when these changes increase board busyness, thus affecting their effective judgment and monitoring.

A tremendous amount of the literature focuses on board structure, specifically member independence, but with little emphasis on the value of the board's financial knowledge. The debate on the topic of financial knowledge started with official reports such as the California Public Employees' Retirement System Corporate Governance Market Principles issued in 1997 and the National Association of Corporate Directors Blue Ribbon Commission Report issued in 1998. At the time, both reports recognized the importance of board independence and also recommended financial literacy/expertise for directors, given their importance in monitoring firm activities. However, the 2003 regulations provided by SOX and the NYSE do not explicitly require financial knowledge for the board members; it is only explicitly required for audit committees.

Our research focuses on the importance of the financial knowledge dimension in board structure. Specifically, we examine the effect of having directors on the board and audit committee with relevant experience and/or education in finance on the firm's risk manage-

ment activity and its performance.

1.2 Benefit of financial knowledge for the board

The few papers that investigate the financial knowledge argument for board members support the idea that the financial knowledge of directors adds value to the firm. Indeed, Booth and Deli (1999) and Guner, Malmendier, and Tate (2005) show that boards comprising members with relevant and related financial and accounting knowledge obtain credible and high-quality financial statement evaluations. Agrawal and Chadha (2005) support the benefit of having independent board directors who have financial knowledge. They find that the probability of earnings restatements is lower in firms whose boards have an independent director with a background in accounting or finance. Interestingly, the independence argument taken alone seems to have no explanatory power in their model, which suggests that directors' independence becomes more effective when they also have financial knowledge.

Our paper is the first to establish such a link using the risk management activity channel. To the extent that financially knowledgeable directors have a better understanding of the sophisticated financial tools involved in risk management activities, we expect firms whose boards comprise financially knowledgeable directors to engage more actively in hedging the firm's exposure to risk and to enhance its performance. The literature already shows that sound corporate governance increases firm value. As an additional corporate governance variable, we suggest different dimensions of directors' financial knowledge and the interaction of these dimensions with independence.

Different arguments support the conjecture that financial knowledge should benefit the firm and shareholders, particularly in the gold mining industry. First, derivatives are sophisticated instruments and directors need a minimum level of financial knowledge to understand them and adequately monitor their management, as in fixing the optimal level of risk management and choosing appropriately between options or futures instruments in different risky environments. In addition, directors overseeing risk management need to understand that derivatives can affect officers' incentives (chief financial officer and CEO) to act in line with shareholder welfare. We refer to the agency aspect of governance related to risk management activities. It is well documented that officers' holding firm options can avoid introducing incentives to reduce the volatility of firm value, because lower volatility reduces their own options value when they are out of the money.

Second, financial knowledge is often measured by directors' experience in finance and their background in accounting. There is no explicit consideration of the financial education dimension, which may be relevant to the usage of hedging instruments. Although in our sample many directors are educated, their education may not be relevant to risk man-

agement activities. For instance, some directors have knowledge related to their business activities (engineers, communication specialists, lawyers, etc.) but not to finance. These directors may not be aware of all the instruments available to hedge a firm's exposure to risk and may not even fully understand the costs and benefits of the effective usage of sophisticated financial instruments. In this paper, we argue that the financial knowledge of directors leads to the sound corporate governance of risk management and sound corporate governance leads to more effective risk management activities, which leads to higher firm performance. Thus we propose the following hypothesis.

H1: The financial knowledge of directors sitting on the board has a significant effect on firm value through the optimal risk management activities channel.

1.3 Benefit of financial knowledge for the audit committee

The audit committee's primary task is to oversee the firm's corporate reporting and ensure the reliability of its financial reporting. Periodic review of the firm's risk assessment system and the managerial actions used to manage its risks is a critical step toward fulfilling this task. We would expect audit committees satisfying the SOX and/or NYSE rules to provide effective monitoring. Moreover, the NYSE's rules require the audit committee to discuss the guidelines and policies for risk assessment and risk management.

To the best of our knowledge, no study establishes a relation between the composition of the audit committee, the backgrounds of its members, and corporate hedging. Our paper is the first to establish such a link. Because audit committee members with financial backgrounds have the experience and training to understand risk management operations, we expect firms with financially knowledgeable directors to engage more actively in risk management when risk management increases firm value. Thus, we address the question of whether we should explicitly require financial knowledge for directors sitting on the audit committee and whether this requirement affects risk management and firm performance. We think that the audit committee, through it monitoring role, should be qualified to deal with the financial environment, especially in critical financial episodes. Thus, we propose the following hypothesis.

H2: The financial knowledge of directors sitting on the audit committee has a significant effect on firm value through the risk management activities channel.

1.4 The independence argument

The standard approach in corporate finance is to view the board's independence as closely related to its efficiency. Following the same reasoning, Section 303A.01 of the NYSE's listed companies manual requires a majority of independent directors on the board. Indeed, outside directors are viewed as superior monitors because their careers are not tied to the

firm's CEO and consequently they are free to take decisions that may go against the CEO without being afraid for their positions or future compensation. This view is often referred to as the monitoring effect theory.[6]

Outside directors have also incentives to build reputations as expert monitors to obtain additional director appointments and are thus more likely to maintain proper control over the firm's top management (Fama, 1980; Fama and Jensen, 1983). However, they are faced with the challenge of understanding the firm's operations, which puts their reputation in play in case of failure. The most recent study by Armstrong, Core, and Guay (2014) shows that firms with more independent directors sitting on the board are more transparent. This has the effect of reducing the uncertainty about the firm's cash flows and thus increasing its value.

The independence argument is also a concern for members of the audit committee. A large body of academic literature has investigated the extent to which the independence and financial literacy/expertise of audit committee members are beneficial to shareholders, specifically members with an accounting background.[7]

However, another stand of the literature questions the benefit of having independent directors on the audit committee. The reason is that there is no consensus that the presence of outside auditors provides additional benefits to the firm. For instance, Beasley (1996), Hayes, Mehran, and Scott (2004), and Agrawal and Chadha (2005) provide arguments against the benefits of having independent auditors, while Carcello and Neal (2000), Abbott, Parker, and Peters (2002), and Klein (2002) show that the presence of independent auditors is beneficial to the firm.

Few papers link board composition to firm risk management activity. Again, the literature does not arrive at a clear consensus on the effect of outside directors on a firm's risk management policy. For instance, Mardsen and Prevost (2005) report no effect of having outside directors on risk management activities. However, Fields and Keys (2003) claim overwhelming support for outside directors providing superior monitoring and advisory functions to the firm. Whidbee and Wohar (1999), Borokhovich, Brunarski, Crutchley, and

[6]Several papers report evidence supporting the monitoring effect theory (Weisbach, 1988; Rosenstein and Wyatt,1990; Dechow and Sloan, 1996; Cotter, Shivdasani, and Zenner,1997; MacAvoy and Millstein,1999; Klein, 2002; Saat et al.,2011), while other studies report evidence against it (Fosberg, 1989; Hermalin and Weisbach, 1991; Klein, 1998; Bhagat and Black, 2002; Hayes, Mehran, and Scott, 2004).

[7]Agrawal and Chadha (2005) support the benefit of having independent members but with a background in accounting or finance. Abbott, Parker, and Peters (2002) find that the absence of a financial expert on the audit committee is significantly associated with an increased probability of financial misstatement and financial fraud. Xie, Davidson, and DaDalt (2003) show that the presence of investment bankers on the audit committee is associated with lower discretionary accruals in the firm. Davidson, Xie, and Xu (2004) and DeFond, Hann, and Hu (2005) report a positive market reaction following the appointment of new directors with auditing/accounting experience. Dhaliwal, Naiker, and Navissi (2010) show that the accounting expertise of the audit committee is positively associated with accruals quality, which suggests that accountants are more effective in executing the audit committee's responsibility of insuring financial reporting.

Simkins (2004), and Dionne and Triki (2013) find that hedging increases with outside directors.

Since risk management is a complex activity, we argue that the requirement of director independence is necessary but not sufficient. Independent members of the board and the audit committee also need a minimum level of financial knowledge (education, experience, and accounting) to monitor risk management activities. Many analysts of the 2007 financial crisis have mentioned that existing regulations are more focused on independence and accounting education than on financial knowledge. Thus, we test the effect of independence and its interaction with the level and type of financial knowledge of directors on risk management and firm value. We propose the following hypothesis.

H3: The independence of directors has a significant effect on risk management activities and firm value through its interaction with financial knowledge.

1.5 The higher education aspect of financial knowledge. Does it matter?

A main exercise in our data collection is to explore the graduate financial background of directors. We are aware that a sufficient number of directors in our sample have a graduate diploma in a physics-related area. However, we argue that the dynamic management of derivative instruments requires a minimum level of financial sophistication and expertise. Extending the above argument, we propose that directors with higher financial education are more willing to react to unanticipated changes in gold prices by making proper adjustments to risk management policy to limit the firm's exposure to risk. Thus, we propose the following testable hypothesis.

H4: Financially educated directors should be more effective than the average industry in adjusting their hedging behavior following unexpected shocks to gold prices.

2 Data and variables

2.1 Sample construction (1992–1999)

Observations on the composition of the board and the audit committee are published only on an annual basis in the firm proxy statement. We assume that the characteristics of corporate governance of the firm remain constant between two consecutive general annual meetings. We believe this assumption is reasonable since, at the general annual meeting, directors are usually elected for terms of at least one year. Moreover, the main issues of corporate governance (risk appetite, risk management policy, risk management strategy, control process) are usually discussed once a year with the board.

We first check the fiscal year-end for each firm in the sample during the period considered. Next, we match the general annual meeting date with the closest fiscal quarter-end

to determine in which fiscal quarter the meeting occurred. For example, if the fiscal year ends on December 31, 1997, and the general annual meeting is held on May 28, 1997, we suppose that the general annual meeting is held in the second quarter of the fiscal year 1997. Then, we collect data on the characteristics of the firm's corporate governance. To limit endogeneity and simultaneity issues, all our independent variables are measured one quarter prior to the quarter in which the hedge ratio is observed. Therefore, we use the corporate governance data collected from a proxy statement for all the risk management observations following the quarter in which the general annual meeting is held and we stop at the quarter in which the next annual general meeting occurs. If we observe that the 1998 general annual meeting is held in the second quarter of 1998, the corporate governance data collected from the 1997 proxy statement is used for the third and fourth quarters of 1997 and the first and second quarters of 1998. Figure 1 summarizes the procedure used to construct our sample.

[Insert Figure 1 about here]

We use Compustat Quarterly to collect firm-specific data such as the market and book values of assets, the total value of debt, the value of sales, operating income, acquisition expenses, selling and general expenses, depreciation and amortization, and other data needed to compute variables describing firms' general characteristics listed in Appendix A.

We use firms' proxy statements and annual reports to hand-collect information about the size and composition of the board and the audit committee, the name of each director sitting on the board and on the audit committee, the education level of each director, the current and former functions of each director, the age of the CEO and the CEO's portfolio holding of common shares and exercisable options.

We drop firms that were acquired, that filed for bankruptcy, or for which management was unable to locate the proxy statements or quarterly reports for the fiscal years we requested.[8]

We also hand-collected data relative to firms' operating cash costs and exploration expenditures from quarterly reports. We proxy taxable income by taxable accounting earnings before extraordinary items and discounted operations. This information is needed to construct the Tax_save variable further documented in Appendix B. Data about institutional shareholding are from the 13-F and 13-G forms available on the U.S. Securities and Exchange Commission website and from proxy statements. Our sample consists of

[8]Proxy statements and quarterly reports for the period ranging from January 1992 to December 1999 are not available from EDGAR (for US firms) or SEDAR (for Canadian firms) for many quarters. For instance, in SEDAR, no data are available before January 1997. We had to directly contact firms and ask them to send us the proxy statements and quarterly reports that were missing in our sample.

348 quarter–company observations and spans the period from January 1992 to December 1999.[9]

We categorize directors as independent if they are not related to the management of the firm and are free from any interest or relationship that could conceivably affect their ability to act in the firm's best interest, other than interest arising from shareholdings. We eliminate current or former employees of the firm or a related entity, directors who are employees, and partners or owners of companies that provided some service to the sample firm or received some compensation from it during the fiscal year. Therefore, we track the biographical backgrounds of directors and officers, the compensation of directors, and any relationships and related transactions available in the proxy statements or in the data sources listed in Appendix C.

We categorize directors as financially active or with experience if they occupied presently or formerly a position as chief financial officer, treasurer, officer of an insurance or investment company or a mutual fund, financial analyst, financial consultant, banker, or any other position related to finance. By tracking the financial knowledge of directors in our data sources listed in Appendix C, we obtained information about 70% of the directors in our sample. Therefore, we had to send an information request to the remaining 30% of the directors asking for details about their financial background. To increase the response rate, we contacted i) the directors themselves, ii) the firms where the directors currently or previously served on the board and/or the audit committee, and iii) other firms not in our sample where the directors currently or previously served on the board and/or audit committee. Data collection using the questionnaire became challenging because several directors in our sample had already retired or died and in those cases firms are not obligated to disclose information about them.

We categorize directors as financially educated if they hold a finance degree or were enrolled in a program offering finance courses (BBA, MBA, CA, BCom, etc.). Several directors in our sample had been enrolled in qualified professional programs, by which we mean that we checked that the curriculum of the professional program contained a sufficient number of finance courses to qualify as a finance degree.

Finally, we categorize directors as accountants if they have an accounting background or are Chartered Accountants (CA, CPA) or have an education or activities related to accounting. Our final sample consists of 325 observations with complete information about the educational background of the directors and 348 observations with complete information about all the other variables listed in Appendix A. Our sample contains 36 North American gold mining companies comprising 25 Canadian firms and 11 US firms.

[9]Note that the majority of Canadian firms in our sample are listed in US exchanges. Accordingly, they are subject to US legislation.

2.2 Variable definitions

2.2.1 Dependent variable

Following Tufano (1996), we measure a firm's risk management activity by the delta percentage. Detailed information used to construct this variable was gracefully provided by Ted Reeve. The delta percentage for a given quarter measures the fraction of the planned gold production to be hedged over the next three years. To obtain the hedge ratio for each firm–quarter, we first calculate the delta of each instrument that is used to hedge the production over the next three years. Then, we multiply each delta by the size of the hedged position, that is, the number of ounces of gold that are covered by the corresponding instrument. Hence, we obtain what Tufano (1996) calls the delta ounces. The delta of the portfolio to be hedged by the firm is obtained by summing over the different delta ounces. Finally, we divide the delta of the portfolio to be hedged by the expected production of gold over the same three years of the hedge and obtain the delta percentage. Hereafter, we refer to the delta percentage as the hedge ratio variable. We plot the median value of the hedge ratio in Figure 2.[10]

[Insert Figure 2 about here]

2.2.2 Independent variables

Our research question aims to evaluate the impact of the independence and financial knowledge of directors sitting on the board and/or the audit committee on firm value through corporate hedging behavior. Therefore, our choice of key independent variables is dictated by the two sets of regulations considered in this study. Although we report all the variable definitions in Appendix A, we highlight here some important key variables. Specifically, we consider whether directors of the audit committee are independent and whether the committee has at least a member who is a financial expert, as required by SOX. We therefore include the following variables and we split the definition of financial expertise into three main categories:

- The audit committee is entirely composed of independent directors (Tot_Indep_Aud),
- At least one member of the audit committee is financially active (One_FinAct),
- At least one member of the audit committee is financially educated (One_FinEdu),
- At least one member of the audit committee has an accounting background (One_Acc_aud).

[10] See Tufano (1996) for more details on the construction of the delta percentage.

We construct additional independent variables to test for NYSE requirements. Specifically, we test the requirement of independence, financial literacy, and a minimum of one audit member with accounting expertise. Thus, we include the following variables:

- Whether the board has a majority of independent directors (Maj_Indep_Bor),
- Whether the audit committee has at least three members ($Min\_\mathrm{Si}ze\_Aud$),
- Whether the majority of directors sitting on the audit committee are financially active (Maj_FinAct),
- Whether the majority of directors sitting on the audit committee are financially educated (Maj_FinEdu),
- The proportion of directors sitting on the audit committee with an accounting background ($\%\_Acc$).

As Dechow, Sloan, and Sweeney (1996), we use a cutoff rule of 50% to define the majority. We verify that no firms in our sample have an audit committee entirely composed of directors with an accounting background. Thus, we cannot test the benefit of having only accountants but we can test the effect of having higher versus lower proportions of accountants on the audit committee (%Acc). To evaluate the effect of the financial background and independence of the board on the level of hedging, we include the following variables:

- The proportion of independent directors sitting on the board ($\%\_Indep$),
- Whether the majority of directors sitting on the board are financially active (Maj_FinAct),
- The proportion of directors on the board with an accounting background ($\%\_Acc$),
- Whether at least one member of the board has an accounting background (One_Acc).

New regulations under SOX and the NYSE require financial literacy only for members of the board who are sitting on the audit committee. Thus, we consider the benefit of having a majority of members of the board with financial expertise (Maj_FinAct).

We should emphasize that our definitions of financial literacy allow for the possibility of overlap between the three categories defined earlier. For instance, a financially active director can also be educated and/or have an accounting background. Thus, we further decompose the three major categories of financial knowledge to test the marginal effect of each dimension.

- A director is financially active, educated, and an accountant ($FinAct\_Edu\_Acc$),
- A director is financially active, educated, and not an accountant ($FinAct\_Edu\_NotAcc$),
- A director is financially active, not educated, and not an accountant ($FinAct\_NotEdu\_NotAcc$),
- A director is not financially active but is educated and an accountant ($NotFinAct\_Edu\_Acc$),

- A director is not financially active, is educated, and is not an accountant ($FinAct\_Edu\_NotAcc$).

According to our definition, directors with an accounting background should also be educated. We illustrate the different cases and definitions of financial literacy in Figure 3 and report descriptive statistics in Appendix D (Tables D-1 and D-2).[11][12]

[Insert Figure 3 about here]

2.2.3 Control variables

As control variables we include determinants of risk management that are well documented in the literature (e.g., Mian, 1996; Tufano, 1996; Haushalter, 2000; Adams and Fernando, 2006). Specifically, we include firm size (ln(size)), the market-to-book ratio of assets (market-to-book), the dividend policy (dividend policy), and the existence of financial slack (quick ratio). Additionally, we control for a firm's expected financial distress costs using leverage (leverage) and the firm's operating cash costs (cash cost). Financial distress costs should increase firm incentives to hedge (Tufano, 1996). Similarly, we control for the firm's investment opportunities using its exploration expenditures (exploration). Firms with attractive investment opportunities should hedge more extensively to ensure the availability of the internal funding necessary to undertake these investments (Froot, Scharfstein, and Stein, 1993; Morellec and Smith, 2002). Finally, we control for the firm's home country by including a variable (dummy US) that equals one if the firm's origin is the United States.

Several papers argue that risk management is more valuable when there is information asymmetry because it will reduce the costs associated with this asymmetry. As Graham and Rogers (2002), we use the percentage of shares held by institutions (%inst) as a proxy for information asymmetry between the CEO and shareholders. This variable can also indicate that these shareholders are more diversified. Risk management activities should decrease with the importance of the firm's institutional holdings as they are willing to take more risks than other stakeholders do.

A firm with a convex tax function should have more incentives to hedge (Smith and Stulz, 1985; Graham and Rogers, 2002). Hedging allows the firm to lock onto the level of taxable income, thus reducing the variability of the pre-tax value of assets and tax liability

[11] Most of the directors in our sample have some level of education, but not in finance. For instance, we count several directors with a bachelor's degree or a PhD in geology, a bachelor's or PhD in electrical engineering, or a bachelor's or a master's in law.

[12] In about 75% of cases, we count at least one audit member who is financially active and, in about 45% of cases, at least one member has an accounting background. However, in 31% of cases, one to two members of the audit committee are financially active, financially educated, and have an accounting background. The majority of the firms have at least one director on the board who is financially active or financially educated (97% of the cases) and at least one director with an accounting background (70% of the cases).

and increasing the after-tax value of assets. To capture the benefits of a convex tax function on hedging, we construct the tax variable (Tax_save) proposed by Graham and Smith (1999). However, these authors consider only US legislation and tax code to calculate taxes for all the firms in their sample. We extend the definition to include the country of origin's legislation and tax code, thus obtaining a more accurate measure of tax savings. We provide more details on the construction of this variable in Appendix B (see also Campello, Lin, Ma, and Zhou, 2011; Dionne and Triki, 2013).

Managerial risk aversion is another important determinant of risk management policy in the gold mining industry (Tufano, 1996; Petersen and Thiagarajan, 2000). We use three proxies for managerial risk aversion: the number of the firm's common shares held by the CEO (CEOCS), the value of options held by the CEO (ValCEOOp), and the CEO's age (CEO age). The two first variables capture Smith and Stulz's (1985) argument that compensation packages leading to a concave (convex) function between the managers' expected utility and the firm's value encourage managers to hedge more (less).[13]

The variable CEO age potentially captures the interplay between experience and education. The literature argues in favor of positive and negative relations between director age and hedging activity. Younger directors may be more inclined to hedge (Tufano, 1996) but older directors facing imminent retirement might prefer reducing fluctuations in a firm's value and hence hedge more extensively. Thus, the variable CEO age could also proxy for risk aversion.

2.3 Summary statistics

Table 1 reports the descriptive statistics for our test and control variables. The hedge ratio indicates that firms in our sample hedge about 17% of their production of gold (as indicated by the median of the positive hedge ratio). The hedge ratio also takes on values greater than one. The maximum of the hedge ratio equals 1.26. We verify that in 17 quarterly observations, the hedge ratio is equal to or higher than one. Therefore, some gold mining firms are likely to hedge for speculation reasons, consistent with the results of Adam and Fernando (2006), who find evidence of speculation (or selective hedging) in the industry of gold mining. However, their results suggest that these firms realize marginal gains from selective hedging.

[Insert Table 1 here]

[13]We focus on the CEO's holdings because i) variables based on directors' and officers' holdings mix the incentives of different agents with different motives and ii) the CEO has the ultimate authority over an important decision such as corporate hedging. However, we consider the option holdings of all officers in the robustness section.

Panel B of Table 1 provides summary statistics of the general characteristics of the firms. Noticeably, our sample contains mostly Canadian firms. Institutions hold, on average, 8% of the shares of the firms, while blockholders hold, on average, 17% of the shares.

Panel C of Table 1 provides summary statistics for the general characteristics of the directors and the CEO. The median director age is 60 years and CEOs are, on average, 54 years old. The average tenure is about six years for both directors and CEOs, which means that they acquired experience with the company. We also note that 66% of the CEOs in our sample are also the chair at the same time.

Panels D and E of Table 1 provide descriptive statistics of the financial backgrounds of directors sitting on the audit committee and the board, respectively. The audit committee is mostly composed of at least three members. In 52% (61%) of cases, the members of the audit committee (board) are independent. The audit committee is composed of at least one financially active member in 88% of cases and at least one financially educated member in 87% of cases. Very few firms (8%) have an audit committee entirely composed of financially active or financially educated members. In about 60% of the firms, directors sitting on the board or the audit committee have a bachelor's degree and, in 33% of cases, they have a master's or PhD degree in finance. In 47% (71%) of cases, the audit committee (board) comprises at least one accountant.

3 The model

Our methodological approach is dictated by the nature of our data. Our dependent variable, the hedge ratio, takes on nonnegative values yet, in about 15% of the observations in our sample, the hedge ratio is equal to zero. An observed hedge ratio of zero reflects the management decision to not hedge. When the observed hedge ratio is positive, it reflects the firm's propensity to hedge. Therefore, the Heckman (1979) two-stage model is best suited to represent our data. Specifically, the first stage models the decision to hedge and the second stage models the intensity of the hedge.

3.1 First-stage of the Heckman model

In the first stage, the dependent variable is a dummy variable; it equals zero if the firms does not hedge and one if the firm hedges. We model the first stage using a probit regression. Independent variables include determinants of the firm's hedging policy: firm size (in logarithmic form), the market-to-book ratio, the leverage ratio, the quick ratio, dividend policy, the benefit of having a convex tax function, and the country of origin (Mian, 1996; Tufano, 1996; Haushalter, 2000; Adams and Fernando, 2006). We also control for seasonal effects in the data using dummy variables for each quarter and year. Using estimated re-

sults from the probit regression, we calculate the inverse Mills ratio to correct for potential sample selection biases.

3.2 Second-stage of the Heckman model

In the second stage, our dependent variable is restricted to positive hedge ratios. At this stage, we address the question of whether the financial knowledge and independence of directors affect a firm's propensity to hedge. In addition to the explanatory variables of the first stage, we include governance variables, such as the size of the audit committee, the independence of directors, and our measures of financial knowledge. We also include firm leverage, the CEO's holdings in shares and options, the convexity of the tax function, the CEO's age, institutional holdings, and the inverse Mills ratio.

Finally, we address a few issues relative to the nature of our data. We use both financial variables published quarterly and governance variables published yearly; we can thus artificially increase our sample size, which could have the effect of biasing standard errors downward and increasing the likelihood of finding significant effects. To avoid problems of data bias, we use firm fixed effects in all our regressions, including the first-stage regressions.

3.3 Endogeneity issues

When estimating the effect of hedging on firm value, we are faced with an endogeneity problem. Adams, Hermalin, and Weisbach (2010) document this issue and report a lack of sufficient instrumental analyses in the corporate governance literature. Many results must be interpreted as the joint selection of governance policy and the policy's effect on firm performance. For example, a firm's hedging activity can be correlated with unobservable characteristics of the firm, in which case the ordinary least square estimates of the parameters in the firm value equation could be biased. We address this endogeneity issue using three complementary approaches. One approach is to find a suitable instrument for the hedging equation and use the predicted value of hedging in the firm value equation. As Campello, Lin, Ma, and Zou (2011) and Dionne and Triki (2013), we use the government rules on corporate taxes that we capture using a measure of tax convexity. This measure will then serve as an instrument in the hedging equation and it is measured as the variation in expected tax savings from a 5% reduction in the volatility of taxable income (Graham and Smith, 1999). The key argument is that tax convexity provides incentives to increase hedging but there is no reason to expect it to directly affect the value of the firm. Under this premise, tax convexity is an adequate instrument for hedging in the firm value equation.

Second, the governance variables change annually while our hedge ratio variable is measured quarterly. More importantly, in the two-stage regression analysis, we use our governance indexes to represent a weighted average of potential explanatory variables. We also apply principal component analysis (PCA) to construct two principal factors accounting for most of the total variance in our set of governance variable candidates for the board and audit committee. By means of orthogonal transformation, PCA converts our set of observations of possibly correlated variable candidates into a set of linearly uncorrelated variables represented by the principal component. As documented in the recent econometric literature, such principal components can be considered instrumental variables (Bai and Ng, 2010).

Next, we model hedging activity and firm performance simultaneously using three-stage simultaneous systems of equations. Specifically, the system is based on Zellner's seemingly unrelated regression estimation (SURE) combined with a two-stage least squares estimation for each equation. We also include our two governance indexes as explanatory variables along with the tax savings variable. Finally, we use the PCA governance factors, which can also be considered instrumental variables. The results remain similar to those of the two-stage regression analysis.

4 Empirical results

4.1 Corporate governance effect on risk management

We report the results of the first stage of the Heckman two-stage model in Appendix E, Table E-1. Consistent with previous findings in the literature (Adam and Fernando, 2006), the decision to hedge is related to the size of the firm, the market-to-book ratio, and the dividend policy. Larger firms are more likely to hedge, which is consistent with the view that small firms may lack the financial resources or capacity required to undertake hedging activities. Similarly, we find that firms distributing dividends are more likely to hedge, while firms with important growth prospects are less likely to hedge. This result is actually consistent with the positive effect of size, since small firms have more growth opportunities and distribute fewer dividends. Note that the negative relation between the decision to hedge and the market-to-book is consistent with the evidence of Mian (1996), Adam and Fernando (2006), and Adam, Fernando, and Salas (2012). The results in Table E-1 also suggest that the decision to hedge is unaffected by the liquidity of assets, the level of leverage, the country of origin, and the magnitude of tax savings from hedging (convexity). Throughout all regressions of the paper, we include 10 control variables widely used in the literature to explain risk management intensity (e.g., Tufano, 1996; Graham, and Rogers, 2002; Adam, 2009; Campello, Lin, and Zou, 2011). Five out of 10 variables are

always statistically significant, with the predicted sign. Specifically, the leverage has a positive and significant sign, suggesting that highly leveraged firms hedge more to reduce their expected default costs (Stulz, 1996). The tax advantage measured by the convexity of the tax function also has a positive and significant sign, as predicted (see also Campello, Lin, and Zou, 2011; Dionne and Triki, 2013). Firms hedge ex ante to reduce their expected tax payments. The percentage of institutional holdings (%_inst) reduces the propensity of hedging. Intuitively, these large institutions are well diversified and less prone to hedge. They can also reduce the information asymmetry between the CEO and shareholders. Finally, we also find that CEO share holdings increase the firm's hedging activity, whereas CEO option holdings decrease it. The argument is that risk-averse CEOs with higher share holdings tend to protect their capital by hedging more. Those with high option holdings will tend to hedge less to increase the value of their options (Stulz, 1996; Tufano, 1996). However, the second argument does not support the dynamic behavior of risk-averse investors shown by Carpenter (2000). We address this argument in the robustness section of the paper.

We also find that size, market-to-book and dividend policy are not significant in the second stage, although they are significant in the first stage. The quick ratio and CEO age are not significant in either stage. See for instance Table 2.

[Insert Table 2 here]

4.2 Importance of financial knowledge

We first test the effect of the financial knowledge of the members of the audit committee using our broad definition of financial knowledge (i.e., experience combined with education in finance and accounting). Our sample is about 76% comprised of audit committees with at least one financially active member (who may also be educated and an accountant) and 41% comprised of committees that are totally independent.[14]

Our first set of results (not reported here) indicates that having at least one financially active member on the audit committee has an insignificant effect on the hedging behavior of the firm, even for a totally independent committee. We further test this result using a stricter definition of financial knowledge. We therefore separate the effects of directors who i) are financially active, educated, and an accountant, ii) are financially active and educated and not an accountant, and iii) are financially active, not educated, and not accountant.

The main conclusion of this section can be summarized as follows. The SOX and NYSE requirements of the independence of the audit committee are always significant, while the NYSE requirement of a majority of independent directors on the board is never significant.

[14]For conciseness, we do not report all the results here; they are available upon request.

However, the independence argument plays a key role in defining the direction of the relation between the dimensions of financial knowledge and hedging activities. Specifically, when independence enters into the interaction with the experience or education dimensions of financial knowledge, the main sign of the effect reverses. Specifically, related directors lead to less hedging activity and independent directors lead to more hedging activities when they have experience and/or education. These relations are reversed in the presence of members with an accounting background. Thus, the effects of governance on hedging activity are determined by the interplay between i) the independence argument, ii) the presence of accountants, and iii) experience and/or education in finance. We develop the details in the following sections.

4.3 Experience in finance

Table 2 summarizes our results drawn from the first definition of financial knowledge, that is, financial experience, with Panels A and B reporting results for the audit committee and the board, respectively. For simplicity and conciseness, we label our main variables using letters (as indicated in the corresponding tables). In Panel A of Table 2, total independence (A) and minimum size (B) both have positive and significant coefficients in almost all specifications, showing that audit committees entirely composed of unrelated directors and those counting at least three members have a positive impact on hedging activities.

Our results suggest that an audit committee with relevant experience in finance leads the firm to hedge more (variable C in Equation (1), representing 42% of firms in our sample). Interestingly, this effect is only significant for related audit members (variable C in Equation (2)) and becomes insignificant for independent audit members (variable D in Equation (2)). It also appears that the experience of at least one member of the audit committee (representing 33% of a three-member committee) has an effect on the firm hedging decision, while the percentage of directors with experience becomes nonsignificant (Equations (3) and (4)).

We also find that this positive relation reverses its sign when audit members are also educated. Specifically, the presence of audit members with education in finance has an effect on the hedging behavior of the firm only when independence is accounted for (variables (E) and (F) in Equations (2) and (4)). When the audit committee comprises one or more educated members, the firm tends to hedge more if these members are independent and hedge less when they are dependent. Thus the independence argument is key in understanding the effect of directors' financial knowledge on the risk management behavior of the firm.

Our results partially support the conclusions of Abbott, Parker, and Peters (2002), Xie, Davidson, and DaDalt (2003), and Agrawal and Chadha (2005) on the benefits of having

financially active directors sitting on the audit committee. However, we show that the effect on hedging depends on whether the members are related to or independent of the firm. Our results also support the SOX requirement that all public companies need at least one "independent qualified financial expert" sitting on the audit committee to help the firm use sophisticated financial instruments for hedging. Panel B of Table 2 summarizes the results for board members. The NYSE regulation requires that listed companies have a majority of independent directors. In our sample, about 74% of the firms have a board with a majority of unrelated directors. Our results indicate that the main effect of this requirement on hedging is not significant. In unreported analysis, we consider the percentage of independent directors instead of the majority and find a positive and significant effect on hedging (results available from the authors). This suggests that a certain number of independent directors on the board positively affect the firm's hedging behavior. However, when their number constitutes a majority, the marginal benefit from adding more independent directors to the board decreases and even becomes insignificant.

Overall, the main conclusions remain stable for directors on the board. Specifically, having board members with experience and without certified education in finance affects the firm's risk management behavior. When these members are insiders, the firm tends to hedge more and, when they are outsiders, the firm tends to hedge less (variables (C) and (D) in Equations (1) and (2), Panel B of Table 2). As shown for the audit committee, education reverses the sign of this relation. When directors are also educated, firms tend to hedge more when they are independent and less when they are dependent (variables (E) and (F) in Equations (1) and (2), Panel B). In addition to the previous results, the presence of directors with an accounting background tends to have the same effect as for directors with experience (variables (G) and (H) in Equations (1) and (2), Panel B).

Throughout the paper, the Inverse Mills ratio has an insignificant coefficient in all specifications, suggesting that our sample does not suffer from serious selection bias. Thus, we can combine positive and zero hedge ratios in the same regression in subsequent analyses.

4.4 Education in finance and an accounting background

In Table 3, we report the results obtained with our second and third definitions of financial knowledge, that is, financial education and an accounting background, since accountants are always educated, according to our definition (see also Appendix E-2 for more details). To account for education in finance including an accounting background, we consider those directors who are i) active, educated, and an accountant, ii) active, educated, and not an accountant, iii) not active but educated and an accountant, and iv) not active but educated and not accountant. Overall, about 90% of the audit committees in our sample contain at least one financially educated director, with each of the four education subgroups repre-

senting between 22% and 40% of the firms. However, there are very few observations with all directors on the audit committee belonging to each of the four education subcategories (between 0.8% and 3% of firms).[15]

[Insert Table 3 here]

The effects of the independence and minimum size of the audit committee remain unchanged, as shown in Panel A of Table 3, Equations (1) and (3). The variable (C) has a negative and significant sign in Equation (1), suggesting that the presence of at least one educated member on the audit committee has an effect on the firm's hedging activity and this effect is negative. Equation (2) distinguishes between related and unrelated members of the audit committee. Taking independence into account suggests that the negative sign is due to related directors (variable C). Independent and educated directors hedge more (variable D). The same effects are also observed with educated directors who have an accounting background (variables I and J in Equations (1) and (2)). When we consider the percentage of audit members in Equations (3) and (4), our main conclusion remains unchanged and suggests that education and independence are related and they both affect a firm's risk management behavior. When directors are related, the firm tends to reduce its hedging activity but, when they are unrelated, the firm tends to increase its hedging activity. We find that educated members on the board lead the firm to hedge more (variables (E) and (G), Equation (1), Panel B). When financial knowledge variables interact with independence, we find that independent directors still encourage the firm to use derivatives (variables (D) and (H), Equation (2), Panel B). However, related directors do not affect firm hedging behavior (variables (C) and (G), Equation (2), Panel B), except when the members are certified accountants without previous experience in finance (variable E, Equation (2), Panel B).

Overall, our results suggest that the independence of directors matters in explaining the effect of financial knowledge on hedging. Generally, accountants restrain the firm from using derivatives, while independent educated directors encourage it to use derivatives. We explore the level of education in a subsequent section in which we break down the education dimension into undergraduate and graduate levels.

4.5 Director quality as a measure of corporate governance

We showed that the independence, financial knowledge, and academic background of the members of the audit committee and the board affect the firm's hedging behavior. The members of the board are directly responsible for the firm's risk management strategy,

[15] By our broad definition of financial education, about 15% of the firms in our sample comprise audit committees who members are all financially educated (with or without experience or an accounting background).

whereas the audit committee members monitor and control board decisions that can affect hedging decisions. Our results in Tables 2 and 3 suggest that independence is very important for the audit committee and less important for members of the board. However, independence plays a key role in defining the sign of the effect of financial knowledge dimensions on the firm's hedging behavior for both the audit committee and the board. Thus, the three dimensions of financial knowledge should affect corporate governance, along with independence and CEO–board relation.

We therefore construct two governance indexes to account for all of these features and test the effect of our governance measure on the firm's risk management behavior. Specifically, we use a scoring system to assess the quality of the audit committee and the board. The score is built such that it increases with each dimension of financial knowledge. It also increases with compliance with the SOX and NYSE requirements of independence and their definition of financial knowledge. However, the score decreases with the CEO level of entrenchment and with directors' tenure. Tenured directors who served the same company for at least 10 years should have acquired relevant experience and learned from the different challenges across various economic regimes. However, derivative instruments are relatively new during our sample period and we are thus inclined to discount the presence of high numbers of tenured directors simply because they may not have developed enough knowledge and experience with these new instruments. We document the construction of both indexes—one for the audit committee and one for the board (GovIndexAud and GovIndexBor, respectively)—in Appendix F. In the robustness section, we reconstruct the two governance indexes using PCA and we discuss the issue of potential endogeneity.

In Table 4, we test the effect of our governance indexes on the firm's risk management behavior, using multivariate regressions in Panel A and the Heckman two-stage model in Panel B (variables are reported in Appendix E-3). Since the inverse Mills ratio was never significant throughout the paper, we use the multivariate regression as a robustness check to observe the hedging behavior of all firms, as opposed to firms that hedge. Equations (1) to (3) of both panels refer to the effects of adding the governance index of the audit, the board, or both, respectively. In all cases, we find that the quality of the audit committee and board significantly affects the observed hedging behavior of the firms in our sample. The higher the governance index, the higher the firm's hedging activity. These results are robust to the model specification. Our control variables, available upon request, remain stable.

Thus, consistent with our previous conclusions, a firm with sound corporate governance is actively hedging its gold position using the derivatives market. Therefore, financial knowledge and independence are important indicators of corporate governance in building our indexes. It would be interesting to verify whether sound corporate governance based on our financial knowledge dimensions also increases shareholder value through the risk

management channel. We address this point in the next section.

[Insert Table 4 about here]

4.6 Hedging behavior and firm performance

Several studies address the question of whether hedging increases the shareholder value. For instance, Jin and Jorion (2006) find support for Modigliani and Miller's theory in which risk management should not affect firm value. Specifically, empirical tests show that hedging against fluctuations of the price of energy does not increase the value of oil and gas firms. Another strand of the literature finds support for firm value maximization theory. Under this theory, markets are imperfect and risk management adds value to shareholders. For instance, taxes, the costs of financial distress, and investment external financing provide positive rationales for risk management (for a review, see Stulz, 1996).

In support of this literature, Allayannis and Weston (2001) find that the use of foreign currency derivatives increases firm value by 4.8%. Carter, Rogers, and Simkins (2006) find that hedging against fluctuations in the price of fuel increases the value of US airlines by approximately 12–16%. Graham and Rogers (2002) report a hedging premium of 1.1%. However, Guay and Kothari (2003) question the evidence in support of value maximization theory and attribute the increase in firm value to other value-enhancing risk management activities and not to hedging.

Using the same sample as in our study, Adam and Fernando (2006) support value maximization theory. They show that gold producers typically lock in a profit of about 3%, using futures contracts.

In line with the literature, we question whether our governance indexes accounting for the quality of directors in terms of financial expertise and independence increase firm value through the risk management channel. Table 5 reports the results for our tests.

[Insert Table 5 about here]

We do not find evidence of feedback effects between observed hedging and firm performance. As shown in Panel A of Table 5, firm performance does not seem to affect hedging levels. Hedging activities in firms with qualified boards and audit committees increase both the firms' accounting and market performance (Panel B). This result supports the views suggesting that risk management is beneficial to firms and their shareholders, while risk management is not endogenously affected by firm performance.

Our measures of the governance indexes are always positive and significant, suggesting that the financial expertise of directors affects hedging behavior and leads firms to hedge more. We find that firm accounting performance is negatively related to the leverage ratio, suggesting that highly levered firms suffer from a heavier debt burden, but limits firm

investment choices and leads to lower accounting performance. However, leverage is positively related to market performance, in line with another strand of the literature, suggesting that highly levered firms have better market performance. According to agency theory, the monitoring provided by debt financing reduces management's incentive to squander free cash flows and should consequently lead to better firm performance. The positive relation between the price of gold and firm performance is intuitive, since firms make more profits when the gold market is bullish because they can close up their positions and sell the gold at a higher price in the spot market. Our instruments in the hedge equation are positive and significant, suggesting that our model does not suffer from endogeneity issues. Since firm performance is not significant in the hedging equation, the potential endogeneity effect of firm performance does not really matter.

For robustness, we re-estimate the model in Table 5 using a different methodology. Specifically, we estimate the model in two stages. In the first stage, we estimate the hedge ratio equation using the same specification as in the previous simultaneous system. This first stage yields the predicted level of risk management (the hedge ratio predicted). In this stage, our control variable for the endogeneity effect is also Tax_save. In the second stage, we evaluate the effect of the predicted risk management on firm accounting and market performance. Since we obtain the same results, we report them in Appendix E, Table E-4.1. In sum, all the coefficients have the same signs as in the simultaneous equation system. The predicted level of hedging has a positive and significant effect on firm performance. Our evidence also confirms that the presence of financially qualified directors on the board and audit committee has a positive impact on hedging equation. Our instrument in the hedging equation has also the same sign as reported in the model with simultaneous equations. As an additional check, we run the second stage of the Heckman model using the specification reported in Appendix E-4. Our conclusions remain unchanged and are robust to the method utilized. Thus, for conciseness, we do not report all the results but they are available upon request. We present additional results in the robustness section.

4.7 Importance of the high education of directors

An important takeaway from repeating our tests with different specifications is that the level of the financial education of directors reshapes the firm's hedging behavior. Specifically, we argue that when directors have the skills required to understand the different operations involved in risk management policy, they will make better risk management decisions. Thus, we are wondering whether our results translate into the necessity of requiring a minimum level of education in finance for both the board and audit committee to ensure more efficient corporate decision making. Of course, we are not saying that directors without a university degree are not capable of making sound management decisions.

Instead, we argue that board decisions on whether to hedge should develop from a better understanding of financial instruments such as derivatives and overseeing the financial impacts of gold price changes on the firm. The clearest impact is that of revenue fluctuations. Other impacts could be from deferring M&A deals, securitizing future sales (a form of hedging), holding off or opening new mines, management compensation, and so forth. A board with strong skills in financial and management reporting, financial planning and analysis, cash management and treasury, risk analysis, benchmarking, banking relationships, and so on, would certainly make better decisions. Note that the best decision may not be to hedge. Strong financial professionals very often recognize uncertainties with financial markets. The best policy for a mining firm may not be to simply lock in supposedly high prices (which involves a good forecast of inflation, interest rates, etc.) but, rather, to cover capital investment and expenses. A well-developed board with strong financial skills is capable of making better decisions. Thus, we argue that high levels of financial education should be important, at least for members of the board who are directly responsible for the firm's risk management.

To test the importance of education, we consider separately the effect of directors having a bachelor's and higher degrees (master's or PhD) in finance on firm hedging activities. We consider two new variables: i) the percentage of directors holding a bachelor's degree in finance (%Bachelor) and the percentage of directors holding a higher degree in finance (%HighEdu). We also consider the interaction between these two variables and the number of educated directors. For the audit, we consider the variable of having at least one director (OneNotActEduNotAcc) or the percentage (%NotActEduNotAcc) of directors educated (since we do not have an audit committee with all educated directors). For the board, we consider the variable for the percentage of directors educated (since we do not have a board with a majority of directors educated in finance). We also include the interaction between the education of directors and their accounting background along with two other new hand-collected variables to account for the education of the CEO. Our results are reported in Table 6 (with more details in Appendix E-5) and can be summarized as follows.

In the audit committee, educated directors holding a bachelor's or higher degree in finance have a positive impact on firm hedging activity (Panel A of Table 6). Specifically, the effect on hedging of having at least one or even a percentage of educated directors without previous experience in the financial market is negative. However, this effect becomes positive when we add interaction with the percentage of directors with a bachelor's or higher degree in finance. When the board comprises more directors with a bachelor's degree or higher in finance, the firm is more engaged in hedging against fluctuations in gold price. Our results reported in Panel B show that both a strong accounting-based board and a CEO with at least a master's degree in finance increase hedging. However, a CEO holding a bachelor degree does not necessarily affect the firm's propensity to hedge.

[Insert Table 6 here]

Firms that are engaged more in risk management could lean toward attracting educated directors, which brings up a potential endogeneity issue. A similar situation is documented by Minton et al. (2010) in the banking industry. To account for endogeneity issues, we simultaneously estimate the equation of the hedge ratio and that of high education (directors with a master's degree in finance or a PhD), using the three-stage least squares method of Zellner and Theil (1962) for each equation. The control variables for the hedge ratio equation include variables of the first stage of the Heckman estimation, CEO age, CEO holdings in shares and options, and the percentage of institutional holdings from the second stage. We also add the governance score, accounting for the financial background of directors sitting on the board or the audit committee and the price of gold, which accounts for market movements. In the high education equation, the control variables include firm size, the market-to-book, and the percentage of institutional holdings. Additional independent variables include the cash fee paid for each meeting to outside directors, the annual fixed fee in the United States, the CEO's number of years of tenure, the average tenure on the board, the average age of the directors, and the number of options held by all directors.

Our results show that a high level of education is important for directors sitting on the board and is insignificant for the audit committee (Table 7). The two governance indexes are always positive and significant, suggesting that the high quality of the board and of the audit committee increases the level of risk management. Most of the control variables are significant and have the predicted sign. We also find that firms with high hedge ratios attract highly educated directors on both the audit committee and the board.

[Insert Table 7 here]

Thus, our results can be summarized as follows: i) Financial education is important for the directors sitting on the board, ii) financial education is important for the directors sitting on the audit committee when they lack financial sector experience, and iii) a board with more directors holding a higher degree in finance is more active in hedging. Our findings provide the first empirical evidence concerning the importance of a university education for the directors sitting on the board and for the CEO. Our conclusions pertaining to board/audit committee independence and other determinants of hedging policy remain unchanged.

4.8 Policy implications

We now focus on the policy implications of our testable hypotheses. Even though the independence and accounting knowledge of directors are accounted for in the current regulation of nonfinancial institutions, it is not clear that these rules are achieving the goal

of the regulation. Regulators have left the notion of financial literacy open to firm interpretation and the concept is rather vague without an explicit regulatory requirement for the financial knowledge of board members. Under some circumstances, the concept is defined endogenously by the board members themselves. During the 2007 financial crisis, it became clear that board members were missing the necessary knowledge to understand the complexity of the financial markets and necessary amendments to current regulations are still needed in the nonfinancial sector. Although the NYSE requires that at least one member of the audit committee have an accounting background, this requirement does not seem to have been very effective.

We test the effect of the SOX and NYSE regulations on risk management activities in Table 8. As explanatory variables in the hedging equation, we add the variables measuring each of the corresponding rules. We also construct six compliance indexes: two for SOX rules, two for NYSE rules, and two indexes for both rules. For each set of rules, we add the variables measuring each of these rules or we multiply them to account for interaction effects. Details on the construction of these indexes are reported in Appendix F.

Our results show that the SOX compliance index always has an effect on risk management activities; however, the NYSE compliance index is not significant in most cases. When we test the model using the index constructed for both the SOX and NYSE regulations, we find a significant effect of regulation on risk management activities that is mainly due to SOX.

[Insert Table 8 here]

To test the effect of the regulations on firm performance, we use a three-stage system of simultaneous equations, thus addressing endogeneity issues. Results are reported in Table 9. We find that SOX regulation remains positively significant in the hedging. However, this positive effect on hedging is not transmitted to shareholders, since we do not find any significant effect of risk management on firm performance. The results for the NYSE regulation remain consistent with a lack of significant effect on hedging. As a robustness check, we estimate the hedging equation using our instrumental variables and we estimate the firm performance equation using the predicted level of hedging. We find similar results for the effect of the regulation on risk management activities. Interestingly, SOX regulation seems to affect firm market performance at the 10% level of confidence through the risk management channel. For conciseness, we report these additional results in Appendix E-4.2.

[Insert Table 9 here]

5 Robustness analysis

5.1 Educated hedging against shocks to gold prices

The main goal of risk management in the gold mining industry is to hedge gold production against unpredictable changes in the price of gold. The question is whether firms with financially educated directors make better hedging decisions than the average of the industry. To analyze this question, we measure educated hedging as the difference between i) the average hedge ratio of firms with educated directors and ii) the average hedge ratio of all firms (industry average). Our test focuses on examining the first movers when the price of gold starts downshifting. To model shifts in gold price, we use the regime shift detection technique of Maalaoui Chun, Dionne, and François (2014) to detect in real time significant shifts in the price of gold. Detected shifts are significant if the change in the price of gold is higher than two standard deviations of the price of gold. We choose to use this detection method because it enables us to detect shifts out of sample as opposed to in-sample detection using a Markov switching regime technique. Another advantage of this detection technique is being parameter free and not requiring initial hypotheses. It also separates shifts in level from shifts in volatility. We use daily gold prices observed during the period of analysis and confirm that a shift has occurred if the confidence level is 95% or higher. The most significant shift is detected in the first quarter of 1997. We use this shift to examine the behavior of educated hedging following unexpected shifts in gold price relative to the industry average. We also test the interaction between educated hedging and gold price regime shifts.

Our results show that, following a regime shift in the gold price, the marginal effect of educated hedging is significantly positive (a regression coefficient of 0.812, significant at the 1% confidence level in Table 10). This means that firms with educated directors are the first movers in hedging against gold prices More interestingly, during low gold price regimes, the coefficient of educated hedging is even higher (a regression coefficient of 2.090 = (0.812+1.278), significant at 1%). These results seems to confirm that firms with educated directors hedge more, especially when prices slope downward. The fact that educated hedging is higher during low gold price regimes seems to further suggest that educated hedging is based on earlier predictions of the movement of the gold price, since firms plan hedge activity before the gold price shift occurs.

[Insert Table 10 about here]

5.2 PCA

Governance quality, not observed directly, has a number of aspects that cannot be captured by a single measure. Because direct measures of governance are unavailable, most

previous empirical studies use different proxies or create indexes to measure governance quality. In this section, we extend the analysis of Section 4.6 by constructing two alternative governance indexes by applying PCA to our governance variables for the board and the audit committee (variable definitions in Appendix F). Specifically, each governance index represents the principal factor that accounts for most of the variation across the different governance variables. This factor is simply defined as a linear combination of governance variables, where the loadings are determined by the PCA (see Appendix G-1). Since our governance variables are dichotomous (zero/one), our PCA is based on the tetrachoric correlation matrix adapted for such variables (e.g., the SAS package for the principal component procedure).

Tetrachoric correlations assume a latent bivariate normal distribution for each pair of discrete variables. The means and variances of the latent variables are not identified, but their correlations can be estimated and are called tetrachoric correlations (Edwards and Edwards, 1984). One can compute pairwise estimates of the tetrachoric correlations using the maximum likelihood estimator obtained from bivariate probit estimations without explanatory variables. The pairwise correlations matrix can then be used to perform a PCA of the binary variables. Tetrachoric correlations permit an intuitive understanding of the size of correlations and this intuition is based on correlations that range from -1 to +1.

In each case, we retain the first principal component, which explains most (47%) of the total variation for governance variables related to the audit committe and (37%) of the total variation for governance variables related to the board. We use these factors as explanatory variables in the simultaneous system of regressions testing the effect of hedging on firm value. We also re-estimate the two equations using the two-stage methodology. The results are very similar to those reported with our governance index constructed using a simple linear combination of the eight variables. Both factors always have positive and very significant coefficients in the hedging equation as reported in Table 11. All variables loadings are reported in Appendix G-1 and complete regression results are reported in Appendix G-2. The hedge ratio has also a positive and very significant effect on firm value. Notice that the two principal factors can be interpreted as instrumental variables in addition to the documented Tax_save variable (untabulated results are available upon request).

[Insert Table 11 about here]

5.3 Effect of option holdings on risk management

The goal of incentive compensation is to motivate managers to make business decisions that increase shareholder value. To test the achievement of this goal, a large literature

studies the relation between executive compensation and companies' economic and financial decisions, with recent surveys by Core, Guay, and Larcker (2003), Aggarwal (2008), Edmans and Gabaix (2009) among others. Unfortunately, there are no strong results in the literature yet that permit conclusions on the incentive effects of such compensation schemes.

Related to our study, many authors have estimated the relation between managerial incentives and corporate hedging. The results suggest that stronger equity incentives are associated with less risk taking to protect officers' capital value, while convexity in executives' portfolios due to options is correlated with less hedging (Tufano, 1996; Guay, 1999; Coles, Daniel, and Naveen, 2006).

We obtain two important results in relation with this literature on hedging. We first confirm that CEOs (or all executives) with call options on the firm's shares hedge less (effect on hedging is always significantly negative), while those with shares hedge more (effect on hedging always significantly positive). Second, we find that less hedging reduces the value of the firm. This suggests that when hedging decisions are motivated by the officers' interests instead of those of shareholders, they result in a negative effect on the firm. These results are obtained with different econometric specifications and are stable with the observed hedging behavior in this industry. Our results extend the results of Tufano (1996). Without an explicit empirical test, Tufano argues that hedging less to increase the volatility of share prices and the value of personal option holdings may have no consequences on firm value when hedging is costless. Our empirical results suggest that less hedging based on personal motives reduces the value of the firm and thus becomes costly to shareholders.

Carpenter (2000) shows that, theoretically, in a dynamic model of hedging where a risk-averse CEO is constrained not to trade his or her options, more compensation with options increases the risk of the CEO's portfolio providing an incentive for the CEO to increase hedging activities to control the volatility of his or her own portfolio. In other words, at equilibrium, giving the manager more options should make the manager hedge more. This hedging incentive is reinforced for a CEO who also holds shares because more hedging also increases the value of these shares. Interestingly, in the gold mining industry, the empirical evidence does not fully support this theory, since the sample firms in which CEOs and officers hold more options tend to hedge less.

We did verify different facts in our data that may provide some directions to answer this puzzle. We first estimate a simultaneous system of equations where, in the first equation, we continue to explain the hedge ratio of the firm and, in the second equation, we explain the value of option holdings either of the CEO or of all officers, including the CEO. In our specifications, we first consider the benchmark system of equations without any governance or compliance variables. Then, we add the two compliance indexes for SOX and the NYSE. In all cases, we obtain the same results; thus we only report the last estimation

in Table 12. The untabulated results are available from the authors. Specifically, the value of option holdings remains negative and significant in the hedge ratio equation, while the variable for officers' option holdings is never affected by the hedge ratio. The officers do not adjust their option holdings in function of the firm's hedge ratio, which is consistent with the assumption of Carpenter (2000). Therefore, the conjecture that they use firm hedging to adjust the risk of their portfolios is reinforced. According to Carpenter, this behavior can be rational for officers with deeply out-of-the-money portfolio option holdings or with less important share holdings.

[Insert Table 12 about here]

We collect strike prices from firms' proxy statements and corresponding share prices in the quarter the option is granted. We then compute the option's value and document its moneyness as reported in Table 13. Among all options granted to officers, 66% are deeply out of the money, 26% are in the money, and about 8% are at the money. These statistics support our conjecture that officers with more option holdings hedge less, to increase their option holding value. They are also consistent with the conjecture of Carpenter (2000), who suggests that officers may have increased incentives to hedge less if their option holdings are out of the money.

[Insert Table 13 about here]

6 Conclusion

The goal of this paper is to emphasize the importance of directors' knowledge and education in finance and/or accounting for the firm and shareholders. Our motivation stems from the recent financial crisis revealing the failure of the board in its task to oversee risk management, mainly because of its limited knowledge and understanding of the risks involved when using complex financial assets. Few papers in the literature address the financial knowledge dimension of corporate governance, mainly because it is very costly to collect detailed data on directors' financial knowledge, since such information does not fall within any explicit regulatory requirement or disclosure obligation. For our purposes, we collected these data for directors in the gold mining industry during a period for which we also have detailed information on firms' observed hedging transactions. These data together create a unique laboratory for analyzing the relation between firms' hedging behavior and directors' financial knowledge and independence. An additional feature of our data is that the sample period ends before the era of major corporate governance scandals, followed by regulatory changes and preparatory work for the 2002 SOX and NYSE regulations. Thus

the observed structure of boards and audit committees in our sample firms does not reflect changes made to comply with these regulations.

Another contribution of our study is our level of detail on directors' financial knowledge. The current definition in the 2002 NYSE regulation is rather vague. We consider three dimensions of financial knowledge and we test how each dimension could affect firm performance. To achieve our goal, we start from the basics that director quality, including independence and expertise with the financial market and financial instruments, enhances the governance of risk management. When the governance of risk management is effective, it should increase firm performance—hence its value. Thus, a firm's observed hedging behavior is our channel to test how effective our corporate governance measures based on financial knowledge are on firm performance.

The main conclusion of our paper is that financial knowledge improves the governance of risk management activities and increases firm performance. Interestingly, our results become even stronger when we interact the independence variable with measures of financial knowledge. Another important result is the interplay between experience and education. Both dimensions affect a firm's risk management behavior in a certain way and both effects are strengthened in the presence of independence. We also construct governance indexes with variables we believe should assess the effectiveness of a firm's governance system. We find that these governance indexes are always associated with higher levels of hedging and, through this channel, increase firm performance after controlling for potential endogeneity issues.

An additional step in our analysis is the exploration of the effects of different education levels on risk management activities. We find that higher education levels (PhD and master's degrees in finance) have more significant effects on hedging than lower education levels (bachelor's degree in finance).

Our study has important policy implications. Since the 2007 financial crisis, regulators have been concerned with the origins of the governance failure with respect to risk management. The follow-up studies of regulators point to the limited knowledge of financial risks by key directors responsible for monitoring and governing major risk management decisions at all firm levels. Indeed, financial markets are dynamic and change continuously by integrating new instruments and various financial products. The boards of directors were not necessarily aware of the rapid evolution of risk management in the beginning of the 2000s and may have misunderstood the functioning of certain instruments, leading to a mis-assessment of firms' real risk exposure. As a matter of fact, many regulatory changes occurred recently for financial institutions, including banks and insurance companies. These regulations mandate the creation of risk committees at the board level, where each member must be independent and must also have sufficient financial knowledge in risk management. When appropriate, the committee should include individuals with tech-

nical knowledge in the risk discipline!

One important aspect recently mentioned by Stulz (2014) is the fact that the audit of risk management differs from the audit of accounting statements. Audits of financial statement mainly have a compliance role. Audits of risk management have a compliance role but the risk committee must also evaluate whether the current risk management policy, although compliant, maximizes the value of the firm. This distinction justifies the creation of two distinct committees in large financial institutions and in nonfinancial institutions with high risk exposure. It also justifies the need for having independent members on the risk committee that have sufficient financial knowledge to accomplish the dual role of their audit.

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Table 1: Descriptive statistics.

This table reports summary statistics (number of observations, mean, median, standard deviation, minimum, and maximum) of all the variables in our analysis. The variable definitions are reported in Appendix A. For the hedge ratio, we report i) the continuous hedge ratio variable for all firms, ii) a dummy variable equal to one if the firm hedges and zero otherwise, and iii) a positive hedge ratio variable for firms that hedge.

Variables	N	Mean	Median	Std Dev.	Min	Max
Panel A: Dependent variables						
$Hedge\_Ratio\ (all\ firms)$	348	0.25	0.14	0.30	0.00	1.26
$Hedge\_Ratio\ (a\ dummy\ )$	348	0.84	1.00	0.36	0.00	1.00
$Hedge\_Ratio\ (firms\ that\ hedge)$	294	0.30	0.17	0.30	0.00[a]	1.26
Panel B: General characteristics of the firms						
$Ln(size)$	344	6.50	6.43	1.49	3.00	9.37
$Market\_to\_Book$	344	1.76	1.64	0.92	0.42	6.00
$Leverage$	343	0.49	0.30	0.57	0.00	3.64
$Quick\_Ratio$	348	3.03	2.08	2.63	0.01	13.50
$Dividend\_Policy$	348	0.76	1.00	0.43	0.00	1.00
Tax_Save	348	0.14	0.05	0.26	0.00	2.18
$\%\_Inst$	348	0.08	0.06	0.09	0.00	0.40
$\%\_Blockholders$	348	0.18	0.11	0.26	0.00	0.91
$Exploration\ (\times 10^2)$	348	0.36	0.24	0.99	0.00	17.39
$Cash\_Cost$	348	246.07	234.00	64.70	116.00	491.00
$Gold\_\mathrm{Pr}ice$	348	335.75	333.65	42.25	280.45	394.90
US_dummy	348	0.45	0.00	0.49	0.00	1.00
Panel C: Characteristics of directors and CEOs						
CEO_Age	348	53.95	54.00	7.54	40.00	75.00
CEO_Tenure	348	6.31	5.00	4.78	0.00	17.00
CEO_COB	348	0.68	1.00	0.47	0.00	1.00
CEO_Change	348	0.11	0.00	0.32	0.00	1.00
CEO_CS	348	1.18	0.06	3.18	0.00	18.01
$ValCEO\_Op$	348	1.70	0.00	6.72	0.00	43.81
$ValAll\_Op$	344	1.38	0.58	2.17	0.00	9.26
$Cash\_Fee\_Outsiders$	348	0.63	0.72	0.36	0.00	1.10
$Annual\_Fixed\_Fee$	348	11.69	8.00	11.45	0.00	50.00
$CEO\_Bachelor$	348	0.15	0.00	0.35	0.00	1.00
CEO_High_Edu	348	0.07	0.00	0.25	0.00	1.00

[a] Specifically, the minimum value for positive hedge ratios is 0.008.

Table 1 (continued)

Variables	N	Mean	Median	Std. Dev.	Min	Max
Panel D: Characteristics and financial background of directors on the audit committee						
Min_size	348	0.91	1.00	0.29	0.00	1.00
Tot_indep	348	0.53	1.00	0.50	0.00	1.00
One_Acc	345	0.42	0.00	0.49	0.00	1.00
One_Fin_know	348	0.89	1.00	0.30	0.00	1.00
One_Act_Edu_Acc	348	0.32	0.00	0.47	0.00	1.00
One_Act_Edu_NotAcc	348	0.24	0.00	0.43	0.00	1.00
One_Act_NotEdu_NotAcc	348	0.42	0.00	0.49	0.00	1.00
One_NotAct_Edu_Acc	348	0.22	0.00	0.41	0.00	1.00
One_NotAct_Edu_NotAcc	348	0.39	0.00	0.49	0.00	1.00
%_Act_Edu_Acc	345	0.12	0.00	0.19	0.00	0.67
%_Act_Edu_NotAcc	345	0.11	0.00	0.23	0.00	1.00
%_Act_NotEdu_NotAcc	345	0.14	0.00	0.18	0.00	0.50
%_NotAct_Edu_Acc	345	0.07	0.00	0.14	0.00	0.50
%_NotAct_Edu_NotAcc	345	0.14	0.00	0.21	0.00	1.00
%_Bachelor	325	0.62	0.67	0.28	0.00	1.00
%_High_Edu	345	0.16	0.00	0.24	0.00	1.00
%_Acc	348	0.19	0.00	0.25	0.00	1.00
All_Fin_know	348	0.29	0.00	0.45	0.00	1.00
Num_High_Edu	348	0.50	0.00	0.73	0.00	3.00
Panel E: Characteristics and financial background of Directors on the board						
Maj_Indep_Bor	348	0.75	1.00	0.44	0.00	1.00
%_Indep	348	0.61	0.60	0.19	0.14	1.00
%_Act	348	0.26	0.24	0.15	0.00	0.71
%_Act_Edu_Acc	345	0.12	0.00	0.19	0.00	0.67
%_Act_Edu_NotAcc	345	0.11	0.00	0.23	0.00	1.00
%_Act_NotEdu_NotAcc	345	0.07	0.00	0.14	0.00	0.50
%_NotAct_Edu_Acc	345	0.14	0.00	0.21	0.00	1.00
%_NotAct_Edu_NotAcc	348	0.11	0.09	0.12	0.00	0.44
%_Bachelor	325	0.61	0.60	0.17	0.29	1.00
%_High_Edu	348	0.13	0.08	0.16	0.00	0.71
One_Acc	348	0.71	1.00	0.45	0.00	1.00
%_Acc	348	0.13	0.13	0.11	0.00	0.43
Num_High_Edu	348	1.19	1.00	1.39	0.00	6.00

Table 2: Effect of directors' financial experience on hedging.

This table reports the results of the effect of directors' financial experience on the hedging behavior of the firm. The model shows results of the second stage of the Heckman selection model. The dependent variable is the delta percentage of the firm that hedges. Independent variable definitions are reported in Appendix A. For the variable $Tot(Maj)\_indep$, we use the total number of independent directors for the audit committee and the majority of independent directors for the board. All regressions have firms fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The notation "i=at least one director" indicates when the financial knowledge variable is true for at least one director. The notation "i=percentage of directors" indicates when the financial knowledge variable is true for a certain percentage of directors. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Directors on the audit comm.				Panel B: Directors on the board	
	i=At least one director		i=Percentage of directors		i=Percentage of directors	
	(1)	(2)	(3)	(4)	(1)	(2)
$Ln(size)$	0.011	-0.004	-0.002	-0.023	0.044	0.035
	(0.21)	(-0.08)	(-0.03)	(-0.43)	(0.89)	(0.71)
$Market-to-book$	-0.02	-0.01	-0.013	-0.009	-0.041	-0.037
	(-0.42)	(-0.20)	(-0.26)	(-0.19)	(-0.87)	(-0.81)
$Leverage$	0.118***	0.126***	0.104***	0.113***	0.124***	0.116***
	(3.66)	(3.87)	(3.06)	(3.30)	(3.98)	(3.83)
$Quick\_ratio$	-0.004	0.002	-0.003	0.001	-0.011	-0.012*
	(-0.57)	(0.24)	(-0.46)	(0.01)	(-1.56)	(-1.80)
$Dividend\_policy$	-0.022	-0.01	-0.031	-0.016	0.013	0.001
	(-0.36)	(-0.16)	(-0.50)	(-0.25)	(0.21)	(0.01)
Tax_save	0.304***	0.291***	0.311***	0.297***	0.278***	0.330***
	(4.08)	(3.78)	(4.13)	(3.87)	(3.75)	(4.55)
CEO_CS	0.069*	0.034	0.075*	0.039	0.091**	0.038
	(1.72)	(0.83)	(1.84)	(0.93)	(2.21)	(0.93)
$ValCEO\_op$	-0.006***	-0.006***	-0.007***	-0.008***	-0.005**	-0.010***
	(-3.06)	(-2.98)	(-3.12)	(-3.01)	(-2.10)	(-3.61)
$\%\_inst$	-0.822***	-0.745***	-0.850***	-0.959***	-0.741***	-0.818***
	(-4.36)	(-3.84)	(-4.22)	(-4.69)	(-3.94)	(-4.46)
CEO_age	-0.003	-0.003	-0.002	-0.002	-0.003	-0.003
	(-0.74)	(-0.78)	(-0.57)	(-0.46)	(-0.87)	(-0.74)
$Tot(Maj)\_indep\_aud(bor) = A$	0.128***	0.063	0.135***	0.033	-0.089	0.066
	(2.70)	(1.03)	(2.79)	(0.53)	(-1.56)	(0.60)
$Min\_size = B$	0.148***	0.118**	0.135**	0.093		
	(2.78)	(2.20)	(2.17)	(1.40)		
$i\_Act\_NotEdu\_NotAcc = C$	0.080**	0.087**	0.113	0.134	0.463***	2.672***
	(2.17)	(2.09)	(1.09)	(1.22)	(2.74)	(4.87)
$i\_Act\_NotEdu\_NotAcc$		-0.019		0.086		-2.544***
$\times Tot(Maj)\_indep\_aud(bor) = D$		(-0.31)		(0.53)		(-4.39)
$i\_Act\_Edu\_Acc = E$	-0.04	-0.120***	-0.142	-0.431***	0.144	-1.490***
	(-1.14)	(-2.73)	(-1.29)	(-2.99)	(0.68)	(-2.49)
$i\_Act\_Edu\_Acc$		0.188***		0.577***		1.250**
$\times Tot(Maj)\_indep\_aud(bor) = F$		(3.13)		(3.44)		(2.08)
$i\_Act\_Edu\_NotAcc = G$	0.041	0.028	-0.059	-0.121	0.891***	1.481*
	(1.06)	(0.56)	(-0.64)	(-1.15)	(2.93)	(1.95)
$i\_Act\_Edu\_NotAcc$		-0.001		-0.167		-0.782
$\times Tot(Maj)\_indep\_aud(bor) = H$		(-0.02)		(-0.67)		(-0.99)
$Inverse\ Mills$	-0.104	-0.044	-0.136	-0.04	0.032	-0.025
	(-0.39)	(-0.16)	(-0.50)	(-0.15)	(0.12)	(-0.10)
$Intercept$	0.105	0.25	0.205	0.427	0.0497	0.106
	(0.27)	(0.63)	(0.49)	(1.01)	(0.13)	(0.27)
$R\text{-}Squared$	0.28	0.31	0.27	0.31	0.27	0.33
$F\text{-}Value\ (p\text{-}value)$	5.01 (0.00)	4.91 (0.00)	4.71 (0.00)	4.82 (0.00)	4.96 (0.00)	5.55 (0.00)
$Observations$	290	290	288	288	290	290

Table 3: Effect of directors' educational background on hedging.

This table reports the results of the effect of directors' educational background on the hedging behavior of the firm. The model shows partial results of the second stage of the Heckman selection model (the complete results of the first and second stages are reported in Appendix E). The dependent variable is the delta percentage of the firm that hedges. Independent variable definitions are reported in Appendix A. For the variable $Tot(Maj)\_indep$, we use the total number of independent directors for the audit committee and the majority of independent directors for the board. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The notation "i=at least one director" indicates when the financial knowledge variable is true for at least one director. The notation "i=percentage of directors" indicates when the financial knowledge variable is true for a certain percentage of directors. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A : Directors on the audit committee				Panel B : Directors on the board	
	i=At least one director		i=Percentage of directors		i=Percentage of directors	
	(1)	(2)	(3)	(4)	(1)	(2)
$Tot(Maj)\_indep = A$	0.120***	-0.048	0.139***	0.018	-0.005	-0.189
	(2.56)	(-0.84)	(2.87)	(0.28)	(-0.10)	(-1.53)
$Min\_size = B$	0.185***	0.134***	0.170***	0.178***		
	(3.47)	(2.53)	(2.54)	(2.46)		
$i\_NotAct\_Edu\_NotAcc = C$	-0.134***	-0.255***	-0.201*	-0.526***	0.119	-0.659
	(-3.41)	(-4.92)	(-1.73)	(-3.59)	(0.52)	(-1.37)
$i\_NotAct\_Edu\_NotAcc$		0.217***		0.254		1.004**
$\times Tot(Maj)\_indep = D$		(3.14)		(1.13)		(2.09)
$i\_NotAct\_Edu\_Acc = E$	-0.029	-0.063	-0.059	-0.442***	0.525**	1.511***
	(-0.85)	(-1.54)	(-0.57)	(-3.02)	(2.08)	(2.49)
$i\_NotAct\_Edu\_Acc$		0.075		0.542***		-0.730
$\times Tot(Maj)\_indep = F$		(1.18)		(2.47)		(-1.10)
$i\_Act\_Edu\_NotAcc = G$	-0.006	0.011	-0.055	0.018	1.049***	0.300
	(-0.17)	(0.26)	(-0.61)	(0.16)	(2.73)	(0.39)
$i\_Act\_Edu\_NotAcc$		-0.013		-0.413		1.227*
$\times Tot(Maj)\_indep = H$		(-0.17)		(-1.49)		(1.67)
$i\_Act\_Edu\_Acc = I$	-0.078**	-0.130***	-0.222**	-0.611***	<0.000	0.537
	(-2.26)	(-3.09)	(-2.01)	(-3.99)	(0.00)	(1.05)
$i\_Act\_Edu\_Acc = J$		0.182***		0.598***		-0.739
$\times Tot(Maj)\_indep$		(3.14)		(3.60)		(-1.40)
$Inverse\ Mills$	-0.068	-0.043	-0.110	-0.086	0.008	0.028
	(-0.25)	(-0.16)	(-0.40)	(-0.32)	(0.11)	(0.34)
$Controls\ \&\ Intercept$	Yes	Yes	Yes	Yes	Yes	Yes
$R\text{-}Squared$	0.31	0.37	0.28	0.35	0.26	0.30
$F\text{-}value\ (p\text{-}value)$	5.30 (0.00)	5.77 (0.00)	4.59 (0.00)	5.18 (0.00)	4.48 (0.00)	4.46 (0.00)
$Observations$	290	290	288	288	290	290

Table 4: Effect of governance indexes on hedging activities.

We report the results of the effect of director quality on firm hedging behavior. Director quality is measured by two indexes: gov_index_board (for the board) and gov_index_audit (for the audit committee). The construction of both indexes is detailed in Appendix F. The table reports the partial results of the multivariate regressions (Panel A), along with the partial results of the second stage of the Heckman selection model (Panel B). The complete results of all the models are reported in Appendix E-3. The dependent variable is the delta percentage of the firm that hedges in Panel A. In Panel B, we report the results of the second stage of a Heckman two-stage model in which the dependent variable is the intensity of the hedge. Independent variable definitions are reported in Appendix A. All the regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Multivariate regression			Panel B: Heckman second-stage regression		
	(1)	(2)	(3)	(1)	(2)	(3)
Gov_index_audit	0.043***		0.041***	0.053***		0.051***
	(2.95)		(2.83)	(3.31)		(3.21)
Gov_index_board		0.023**	0.021*		0.025***	0.023**
		(2.11)	(1.94)		(2.40)	(2.27)
Inverse Mills				-0.285	-0.098	-0.259
				(-1.06)	(-0.37)	(-0.97)
Controls & Intercept	Yes	Yes	Yes	Yes	Yes	Yes
$R-Squared$	0.22	0.21	0.23	0.26	0.24	0.27
F-Value (p-value)	5.78 (0.00)	5.40 (0.00)	5.70 (0.00)	5.59 (0.00)	5.15 (0.00)	5.66 (0.00)
Observations	342	342	342	290	290	290

Table 5: Simultaneous estimation of hedging and firm performance.

This table reports the results of the effect of having qualified directors sitting on the board and the audit committee on the hedging behavior and performance of the firm. We consider the simultaneous estimation of hedging and firm performance to account for endogeneity between the two variables. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. The return on equity (ROE) and return on assets (ROA) measure the firm's accounting performance. Tobin's Q (Tobin's Q) and the market-to-book (MB) measure firm market performance. Panel A reports estimates of the hedge ratio equation and Panel B reports estimates of the firm performance equation. Independent variable definitions are reported in Appendix A. All the regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	ROE	ROA	Tobin's Q	MB
Panel A: The hedge ratio is the dependent variable				
$Firm\_performance$	0.183	0.181	-0.015	-0.009
	(1.01)	(0.45)	(-0.33)	(-0.20)
$Ln(size)$	0.121***	0.122***	0.105***	0.102***
	(3.09)	(2.90)	(2.44)	(2.36)
$Market\_to\_book$	-0.035*	-0.038**		
	(-1.76)	(-1.97)		
$Leverage$	0.102***	0.099***	0.081***	0.080***
	(3.18)	(2.46)	(2.92)	(2.89)
$Quick\_ratio$	-0.003	-0.005	-0.004	-0.004
	(-0.62)	(-1.00)	(-0.86)	(-0.86)
$Dividend\_policy$	-0.001	-0.004	-0.008	-0.007
	(-0.02)	(-0.15)	(-0.30)	(-0.29)
Tax_save	0.172***	0.186***	0.173***	0.173***
	(3.85)	(4.18)	(4.01)	(4.04)
CEO_CS	0.089***	0.101***	0.114***	0.112***
	(2.48)	(2.87)	(2.96)	(2.96)
$ValCEO\_op$	-0.006***	-0.006***	-0.008***	-0.008***
	(-3.02)	(-2.93)	(-3.540	(-3.58)
$\%\_inst$	-0.556***	-0.603***	-0.591***	-0.588***
	(-3.71)	(-4.11)	(-4.04)	(-4.03)
CEO_age	0.002	0.001	0.001	0.001
	(0.74)	(0.68)	(0.54)	(0.54)
US_dummy	1.965***	-0.414	-0.307	-0.289
	(2.90)	(-1.51)	(-0.98)	(-0.93)
Gov_index_audit	0.041***	0.043***	0.050***	0.050***
	(3.24)	(3.39)	(3.76)	(3.88)
Gov_index_board	0.018*	0.020**	0.019*	0.019*
	(1.77)	(2.14)	(1.87)	(1.89)
$Gold\_price$	-0.001*	-0.001*	-0.001	-0.00071
	(-1.74)	(-1.67)	(-1.40)	(-1.52)
$Intercept$	-2.340***	-0.502	-0.425	-0.406
	(-3.29)	(-1.60)	(-1.21)	(-1.16)
Chi-2 (p-value)	1293.52 (0.00)	2514.96 (0.00)	2544.04 (0.00)	2551.75 (0.00)
$Observations$	339	341	341	342

Table 5 (Continued)

	ROE	ROA	Tobin's Q	MB
Panel B: Firm performance is the dependent variable				
$Hedge\_ratio$	0.625***	0.259***	0.848**	0.822**
	(2.40)	(2.73)	(2.03)	(2.00)
$Ln(size)$	-0.083	-0.070***	0.370***	0.384***
	(-1.08)	(-2.51)	(3.26)	(3.44)
$Market\_to\_book$	-0.024	<0.001		
	(-0.62)	(0.01)		
$Leverage$	-0.130***	-0.094***	0.132	0.140*
	(-2.37)	(-4.74)	(1.60)	(1.72)
$Quick\_ratio$	-0.008	0.001	-0.007	-0.008
	(-0.82)	(0.17)	(-0.45)	(-0.57)
$Dividend\_policy$	-0.029	-0.002	0.118	0.088
	(-0.61)	(-0.12)	(1.64)	(1.26)
$Exploration$	1.312	-1.578***	0.407	0.050
	(1.00)	(-3.20)	(0.19)	(0.02)
$Cash\_\cos t$	<0.001	<0.001	-0.002***	-0.002***
	(-1.32)	(-1.07)	(-3.73)	(-3.31)
$\%\_inst$	-0.138	0.118	-1.631***	-1.624***
	(-0.42)	(0.99)	(-3.24)	(-3.28)
$\%\_blockholders$	0.490	0.129	3.332***	3.415***
	(1.58)	(1.20)	(6.84)	(7.13)
Maj_indep_bor	-0.058	0.001	-0.174*	-0.197*
	(-0.87)	(0.04)	(-1.65)	(-1.92)
CEO_age	-0.007	-0.001	-0.006	-0.006
	(-1.33)	(-0.54)	(-0.79)	(-0.75)
CEO_change	0.022	0.032	-0.151	-0.148
	(0.30)	(1.25)	(-1.32)	(-1.32)
CEO_COB	0.010	0.001	0.022*	0.019
	(1.16)	(0.41)	(1.69)	(1.44)
CEO_tenure	-0.029	0.004	-0.203**	-0.215**
	(-0.49)	(0.19)	(-2.12)	(-2.31)
US_dummy	-1.546***	0.223	0.204	0.833
	(-3.61)	(1.16)	(0.31)	(1.28)
$Gold\_price$	0.002***	<0.001	0.010***	0.010***
	(2.35)	(1.07)	(11.26)	(11.13)
$Intercept$	1.862***	0.260	-3.954***	-4.618***
	(3.24)	(1.38)	(-4.62)	(-5.48)
Chi-2 (p-value)	152.49 (0.00)	123.32 (0.00)	1780.99 (0.00)	1737.57 (0.00)
$Observations$	339	341	341	342

Table 6: The importance of education.

We test the effect education on hedging activities and report results of the second stage of the Heckman selection model. In Panel A, we account for the education of directors sitting on the audit committee. In Panel B, we account for the education of directors sitting on the board and the CEO. All independent variable definitions are reported in Appendix A. All regressions have firms fixed effects and includes a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A : Education of the members of the audit committee	(1)	(2)	(3)	(4)	(5)	
Min_size	0.121**	0.126**	0.172***	0.164***	0.132***	
	(2.14)	(2.21)	(3.19)	(2.83)	(2.45)	
Tot_indep	0.089*	0.095**	0.120**	0.139***	0.104**	
	(1.85)	(2.03)	(2.55)	(2.89)	(2.27)	
$\%\_Bachelor$	-0.171***	-0.181***				
	(-2.85)	(-3.09)				
$\%\_High\_Edu$			-0.194*	-0.15559	-0.523***	
			(-1.89)	(-1.48)	(-3.90)	
$One\_NotAct\_Edu\_NotAcc$	-0.235***		-0.193***		-0.148***	
	(-4.51)		(-4.21)		(-3.08)	
$One\_NotAct\_Edu\_NotAcc \times \%\_Bachelor$	0.310***					
	(3.01)					
$One\_NotAct\_Edu\_NotAcc \times \%\_High\_Edu.$			0.396***		0.983***	
			(2.43)		(3.97)	
$\%\_NotAct\_Edu\_NotAcc$		-0.831***		-0.258*		
		(-4.24)		(-1.95)		
$\%\_NotAct\_Edu\_NotAcc \times \%\_Bachelor$		0.956***				
		(4.85)				
$\%\_NotAct\_Edu\_NotAcc \times \%\_High\_Edu$				0.814**		
				(1.99)		
$One\_NotAct\_Edu\_Acc$					-0.204***	
					(-4.57)	
$One\_NotAct\_Edu\_Acc \times \%\_High\_Edu$					0.347**	
					(2.18)	
$R-Squared$	0.33	0.34	0.32	0.28	0.36	
F-Value (p-value)	6.13 (0.00)	6.38 (0.00)	5.76 (0.00)	4.84 (0.00)	6.27 (0.00)	
$Observations$	288	288	288	288	288	

Panel B : Education of the members of the board and CEO	(1)	(2)	(3)	(4)	(5)	(6)
Maj_indep	-0.029	-0.021	-0.004	-0.012	-0.064	-0.046
	(-0.60)	(-0.45)	(-0.09)	(-0.24)	(-1.23)	(-0.98)
$\%\_Bachelor$	0.320***					
	(2.59)					
$\%\_High\_Edu$		1.055***	1.065***	1.142***		
		(5.25)	(5.24)	(5.09)		
$One\_NotAct\_Edu\_Acc$			0.044			
			(1.50)			
$One\_NotAct\_Edu\_Acc \times \%\_Bachelor$			0.432			
			(1.54)			
$\%\_NotAct\_Edu\_Acc$				0.416		
				(1.50)		
$\%\_NotAct\_Edu\_Acc \times \%\_High\_Edu$				1.404		
				(0.50)		
$CEO\_Bachelor$					-0.039	
					(-0.86)	
CEO_High_Edu						0.332***
						(4.26)
R-Squared	0.25	0.30	0.32	0.32	0.23	0.28
F-Value (p-value)	4.97 (0.00)	6.65 (0.01)	6.34 (0.02)	6.28 (0.03)	4.48 (0.00)	5.89 (0.00)
$Observations$	290	290	290	290	290	290

Table 7: Simultaneous effects between hedging and high levels of education.

This table reports the results of the simultaneous estimation of hedging and directors' high levels of education to account for the endogeneity between the two variables. The system is based on Zellner's seemingly unrelated regression estimation (SURE) combined with a two-stage least squares estimation for each equation. Panel A reports estimates of the hedge ratio equation and Panel B reports estimates of the equation for directors' high levels of education. Independent variable definitions are reported in Appendix A. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The hedge ratio is the dependent variable			Panel B: The high level of education is the dependent variable		
	Audit	Board		Audit	Board
$High\_Edu$	-0.039	0.186***	$Hedge\_ratio$	1.114***	1.639***
	(-0.39)	(2.62)		(3.93)	(3.98)
$ln(size)$	0.110***	0.156***	$ln(size)$	-0.448***	-0.362***
	(2.62)	(3.72)		(-4.95)	(-2.47)
$Market\_to\_book$	-0.048***	-0.025	$Market\_to\_book$	0.263***	-0.064
	(-2.36)	(-0.91)		(4.83)	(-0.73)
$Leverage$	0.105***	0.084***	$\%\_inst$	-0.118	0.208
	(3.27)	(3.13)		(-0.31)	(0.32)
$Quick\_ratio$	-0.004	-0.007*	$Cash\_fee\_outsiders$	<0.001	-0.001**
	(-0.86)	(-1.37)		(-1.45)	(-2.32)
$Dividend\_policy$	-0.018	-0.005	$Annual\_fixed\_fee$	0.001***	0.001*
	(-0.73)	(-0.23)		(3.49)	(1.72)
$Taxe\_save$	0.157***	0.212***	CEO_tenure	-0.020***	0.005
	(3.75)	(4.25)		(-2.50)	(0.43)
CEO_CS	0.105***	0.082	$Average\_tenure$	-0.020	0.031
	(2.42)	(1.53)		(-1.23)	(0.50)
$ValCEO\_op$	-0.006***	-0.005***	$Average\_age$	0.002	0.004
	(-3.07)	(-2.68)		(0.19)	(0.10)
$\%\_inst$	-0.571***	-0.515***	$ValAll\_opt$	0.001	-0.001
	(-3.72)	(-2.35)		(1.10)	(-1.24)
CEO_age	<0.001	<0.001	$Intercept$	0.275	2.68*
	(-0.08)	(-0.03)		(0.24)	(1.74)
US_dummy	-0.868***	0.403			
	(2.78)	(0.89)			
Gov_index_aud	0.072***				
	(3.50)				
Gov_index_bor		0.023**			
		(2.08)			
$Gold\_price$	<-0.001	<-0.001			
	(-0.07)	(-0.07)			
$Intercept$	0.126	-1.213			
	(0.290)	(-2.12)			
Chi-2 (p-value)	1266.97 (0.00)	1154.23 (0.00)		1583.15 (0.00)	3540.68 (0.00)
$Observations$	336	321		336	321

Table 8: Effect of the SOX and NYSE regulations on hedging.

This table reports the results of the second stage of the Heckman two-stage selection model. The dependent variable is the intensity of hedging (positive hedge ratios). Independent variables include four compliance indexes to SOX and NYSE regulations, explained in Appendix F. Other variable definitions are reported in Appendix A. All the regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	Compliance with SOX			Compliance with NYSE			Compliance with SOX and NYSE		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$Ln(size)$	0.016	0.015	0.003	0.042	0.041	0.049	0.009	0.047	0.026
	(0.31)	(0.29)	(0.06)	(0.85)	(0.80)	(0.95)	(0.17)	(0.92)	(0.51)
$Market\_to\_Book$	-0.019	-0.020	-0.019	-0.038	-0.042	-0.030	-0.017	-0.035	-0.026
	(-0.40)	(-0.42)	(-0.41)	(-0.80)	(-0.88)	(-0.64)	(-0.36)	(-0.73)	(-0.55)
$Leverage$	0.092***	0.092***	0.088***	0.118***	0.098***	0.106***	0.102***	0.109***	0.114***
	(2.96)	(2.96)	(2.91)	(3.69)	(3.21)	(3.51)	(3.15)	(3.67)	(3.86)
$Quick\_Ratio$	-0.001	-0.002	-0.001	-0.007	-0.006	-0.005	-0.002	-0.006	-0.002
	(-0.21)	(-0.24)	(-0.09)	(-1.05)	(-0.92)	(-0.70)	(-0.26)	(-0.81)	(-0.35)
$Dividend\_Policy$	-0.024	-0.024	-0.017	-0.007	-0.008	-0.017	-0.016	-0.018	-0.032
	(-0.39)	(-0.38)	(-0.28)	(-0.11)	(-0.13)	(-0.27)	(-0.25)	(-0.28)	(-0.52)
Tax_Save	0.281***	0.280***	0.281***	0.279***	0.272***	0.275***	0.291***	0.276***	0.281***
	(3.74)	(3.74)	(3.78)	(3.71)	(3.60)	(3.64)	(3.92)	(3.64)	(3.74)
CEO_CS	0.079**	0.079**	0.077*	0.092**	0.089**	0.084**	0.083**	0.088**	0.084**
	(1.99)	(2.00)	(1.95)	(2.31)	(2.24)	(2.10)	(2.11)	(2.20)	(2.11)
$ValCEO\_Op$	-0.007***	-0.007***	-0.007***	-0.006***	-0.006***	-0.007***	-0.006***	-0.007***	-0.007***
	(-3.20)	(-3.20)	(-3.18)	(-2.57)	(-3.06)	(-3.22)	(-2.40)	(-3.14)	(-3.22)
$\%\_Inst$	-0.641***	-0.638***	-0.654***	-0.750***	-0.689***	-0.623***	-0.791***	-0.642***	-0.522***
	(-3.51)	(-3.50)	(-3.62)	(-4.02)	(-3.69)	(-3.40)	(-4.27)	(-3.44)	(-2.76)
CEO_Age	-0.001	-0.001	-0.002	-0.001	-0.001	0.000	-0.003	-0.001	-0.001
	(-0.41)	(-0.43)	(-0.49)	(-0.20)	(-0.34)	(-0.12)	(-0.75)	(-0.13)	(-0.12)
Tot_Indep_Aud	0.092**						0.138***		
	(2.00)						(2.88)		
$One\_Fin\_Exp\_Aud$	0.054						0.007		
	(0.42)						(0.05)		
$Compliance\_SOX1$		0.088**							
		(2.01)							
$Compliance\_SOX2$			0.153***						
			(2.95)						
Maj_Indep_Bor				-0.046			-0.060		
				(-0.95)			(-1.19)		
Min_Size_Aud				0.090*			0.142***		
				(1.72)			(2.59)		
$All\_Fin\_Exp\_Aud$				-0.042			-0.040		
				(-1.26)			(-1.20)		
One_Acc_Aud				-0.084*			-0.076*		
				(-1.80)			(-1.65)		
$Compliance\_NYSE1$					-0.037*				
					(-1.68)				
$Compliance\_NYSE2$						-0.036			
						(-0.68)			
$Compliance\_SOX\_NYSE1$								-0.013	
								(-0.62)	
$Compliance\_SOX\_NYSE2$									0.086*
									(1.93)
$Inverse\ Mills$	-0.119	-0.116	-0.082	-0.032	-0.040	-0.093	-0.067	-0.092	-0.167
	(-0.44)	(-0.43)	(-0.31)	(-0.12)	(-0.15)	(-0.34)	(-0.25)	(-0.34)	(-0.62)
$Intercept$	0.138	0.120	0.250	-0.002	0.144	-0.032	0.203	0.031	0.116
	(0.35)	(0.31)	(0.65)	(-0.01)	(0.37)	(-0.08)	(0.50)	(0.08)	(0.30)
Adj R-Squared	0.23	0.23	0.25	0.25	0.23	0.22	0.28	0.22	0.23
F-Value (p-value)	4.68 (0.00)	5.00 (0.00)	5.40 (0.00)	4.57 (0.00)	4.90 (0.00)	4.69 (0.00)	4.64 (0.00)	4.69 (0.00)	4.97 (0.00)
$Observations$	290	290	290	290	290	290	290	290	290

Table 9: Simultaneous estimation of hedging and firm performance under SOX and NYSE regulations.

This table reports the results of the simultaneous estimation of hedging and firm performance to account for the endogeneity between the two variables. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. The return on equity (ROE) and the return on assets (ROA) measure firm accounting performance. The Tobin's Q (Tobin's Q) and the market-to-book (MB) measure the firm's market performance. Panel A reports estimates of the hedge ratio equation and Panel B reports estimates of the firm performance equation. Independent variable definitions are reported in Appendix A. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	ROE	ROA	Tobin's Q	MB
Panel A: The hedge ratio is the dependent variable				
$Firm\_performance$	-0.165	-0.346	-0.059	-0.054
	(-0.79)	(-0.74)	(-1.30)	(-1.22)
$Ln(size)$	0.091**	0.082*	0.107***	0.105***
	(2.17)	(1.91)	(2.36)	(2.33)
$Market\_to\_book$	-0.043**	-0.040**		
	(-2.07)	(-2.08)		
$Leverage$	0.065*	0.056	0.082***	0.082***
	(1.92)	(1.31)	(2.91)	(2.91)
$Quick\_ratio$	-0.007	-0.006	-0.004	-0.004
	(-1.09)	(-1.05)	(-0.83)	(-0.82)
$Dividend\_policy$	-0.009	-0.003	0.002	0.000
	(-0.29)	(-0.12)	(0.06)	(0.00)
Tax_save	0.200***	0.209***	0.185***	0.185***
	(4.04)	(4.27)	(4.12)	(4.18)
CEO_CS	0.089**	0.092**	0.095***	0.094***
	(2.16)	(2.29)	(2.34)	(2.35)
$ValCEO\_op$	-0.007***	-0.006***	-0.007***	-0.007***
	(-3.05)	(-2.98)	(-3.14)	(-3.19)
$\%\_inst$	-0.765***	-0.726***	-0.735***	-0.736***
	(-4.85)	(-4.92)	(-4.95)	(-4.99)
CEO_age	<-0.000	<-0.000	<-0.000	<-0.000
	(-0.18)	(-0.05)	(-0.08)	(-0.10)
US_dummy	-1.007**	-0.403	2.051***	2.093***
	(-2.39)	(-1.14)	(2.64)	(2.72)
$Compliance\_SOX1$	0.092**	0.093**	0.101***	0.106***
	(2.03)	(2.22)	(2.43)	(2.57)
$Compliance\_NYSE1$	-0.029	-0.024	-0.024	-0.025
	(-1.50)	(-1.35)	(-1.37)	(-1.41)
$Gold\_price$	0.000	-0.000	0.000	0.000
	(0.20)	(-0.29)	(0.22)	(0.17)
$Intercept$	0.526	-0.154	-2.376***	-2.374***
	(0.94)	(-0.32)	(-2.81)	(-2.83)
Chi-2 (p-value)	1164.44 (0.00)	2527.50 (0.00)	1285.65 (0.00)	1306.33 (0.00)
$Observations$	339	341	341	342

Table 9 (Continued)

	ROE	ROA	Tobin's Q	MB
Panel B: The firm performance is the dependent variable				
Hedge_ratio	0.219	0.057	0.567	0.563
	(0.77)	(0.63)	(1.40)	(1.42)
Ln(size)	-0.034	-0.030	0.346***	0.363***
	(-0.44)	(-1.33)	(3.63)	(3.88)
Market_to_book	-0.036	-0.006		
	(-0.95)	(-0.48)		
Leverage	-0.100*	-0.068***	0.108	0.120*
	(-1.84)	(-4.21)	(1.56)	(1.76)
Quick_ratio	-0.009	-0.000	-0.007	-0.009
	(-1.04)	(-0.08)	(-0.53)	(-0.65)
Dividend_policy	-0.021	0.000	0.121*	0.091
	(-0.47)	(0.02)	(1.73)	(1.34)
Exploration	1.630	-1.644***	0.536	0.201
	(1.17)	(-3.39)	(0.25)	(0.09)
Cash_cost	-0.001	-0.000	-0.002***	-0.002***
	(-1.42)	(-0.83)	(-3.65)	(-3.26)
%_inst	-0.325	-0.005	-1.597***	-1.616***
	(-0.98)	(-0.04)	(-3.44)	(-3.54)
%_bockholders	0.419	0.072	3.261***	3.367***
	(1.29)	(0.65)	(6.86)	(7.21)
Tot_indep_aud	-0.041	0.003	-0.106	-0.127
	(-0.59)	(0.13)	(-1.05)	(-1.30)
CEO_age	-0.007	-0.002	-0.003	-0.003
	(-1.31)	(-1.10)	(-0.42)	(-0.41)
CEO_COB	0.015	0.017	-0.139	-0.143
	(0.20)	(0.69)	(-1.23)	(-1.29)
CEO_tenure	0.013	0.003	0.022*	0.019
	(1.48)	(1.04)	(1.69)	(1.49)
CEO_change	0.017	0.002	-0.141	-0.158*
	(0.27)	(0.10)	(-1.55)	(-1.78)
US_dummy	-0.365	-0.023	-2.677***	-2.824***
	(-1.12)	(-0.22)	(-5.81)	(-6.24)
Gold_price	0.001**	0.001	0.010***	0.010***
	(2.17)	(0.89)	(11.06)	(10.99)
Intercept	0.424	0.275*	-3.300***	-3.277***
	(0.85)	(1.80)	(-5.15)	(-5.21)
Chi-2 (*p*-value)	155.50 (0.00)	110.43 (0.00)	1881.04 (0.00)	1838.72 (0.00)
Observations	339	341	341	342

Table 10: Educated hedging following shocks to the gold price.

This table reports the results on the relation between educated hedging and shocks to the gold price. We model gold price shocks using the regime shift detection of significant changes (two standard deviations) in gold prices. Educated hedging is measured as the difference between the average hedge ratio of educated directors minus the average hedge ratio of all directors in the industry. The regression includes firm fixed effects and a dummy variable for each quarter to control for seasonal effects in the data. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Variables	Coef.
$Ln(size)$	-0.078***
	(-2.38)
CEO_CS	0.089*
	(1.66)
$ValCEO\_op$	0.049***
	(8.48)
$\%\_inst$	0.579***
	(3.98)
CEO_age	-0.002
	(-0.85)
Maj_unr_bor	-0.02
	(-0.46)
$\%NotAct\_Edu\_bor$	0.812***
	(3.62)
$Regime\_goldp$	-0.119***
	(-3.81)
$\%\_NotAct\_Edu\_bor \times Regime\_goldp$	1.278***
	(3.62)
Inv_Mills	-0.134**
	(-1.95)
$Intercept$	0.31
	(1.23)
Adj R-Squared	0.379
F-Value (p-value)	12.97 (0.00)
$Observations$	324

Table 11: PCA.

This table reports the partial results of the simultaneous regression between firm performance and the hedge ratio in the presence of governance indicators. The governance indicators are measured with the principal component of governance variables for directors on the board (PC_gov_board) and directors on the audit committee (PC_gov_audit). Detailed results and control variables are reported in Appendix G. We include a dummy variable for each quarter to control for seasonal effects in the data. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

	ROE	ROA	Tobin's Q	MB
Panel A: The dependent variable is the hedge ratio				
$firm\_performance$	-0.108	-0.340	-0.058	-0.050
	(-0.49)	(-0.77)	(-1.28)	(-1.13)
PC_gov_audit	0.033*	0.038***	0.041***	0.044***
	(1.93)	(2.43)	(2.64)	(2.85)
PC_gov_board	0.045***	0.042***	0.042**	0.041***
	(2.82)	(3.62)	(3.60)	(3.59)
Controls & Intercept	Yes	Yes	Yes	Yes
$Chi2$ (p-value)	1234.97 (0.00)	2606.28 (0.00)	2532.84 (0.00)	2563.08 (0.00)
$Observations$	339	341	341	342
Panel B: The dependent variable is firm performance				
$Hedge\_ratio$	0.647***	0.219**	0.877**	0.824**
	(2.39)	(2.28)	(2.04)	(1.96)
Controls & Intercept	Yes	Yes	Yes	Yes
$Chi2$ (p-value)	159.07 (0.00)	103.07 (0.00)	1759.06 (0.00)	9070.12 (0.00)
$Observations$	339	341	341	342

Table 12: Simultaneous effect between hedging and officers' option holdings.

This table reports the results on the relation between the option holdings of officers including the CEO and those of the CEO on firm risk management activities, using simultaneous system of equations. The system is based on Zellner's SURE combined with a two-stage least squares estimation for each equation. In Panel A the dependent variable is the hedge ratio and in Panel B the dependent variable is the option holdings of officers including the CEO and those of the CEO ($Val(CEO)\_op$). All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are in parentheses. The superscripts ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: The hedge ratio is the dependent variable			Panel B: Option holdings are the dependent variable		
	CEO	All officers		CEO	All officers
$Val(CEO)\_op$	-0.007***	-0.006***	$Hedge\_ratio$	0.331	0.204
	(-3.44)	(-3.22)		(1.23)	(0.85)
$Ln(size)$	0.121***	0.121***	$Ln(size)$	-0.154**	-0.054
	(3.25)	(3.23)		(-2.15)	(-0.85)
$Market\_to\_book$	-0.038**	-0.039**	$Market\_to\_book$	-0.007	-0.068**
	(-2.03)	(-2.07)		(-0.21)	(-2.07)
$Leverage$	0.087***	0.086***	$Leverage$	-0.122**	-0.091**
	(3.21)	(3.16)		(-2.42)	(-2.01)
$Quick\_ratio$	-0.005	-0.005	$Quick\_ratio$	0.031***	0.036***
	(-1.12)	(-1.08)		(3.58)	(4.61)
$Dividend\_policy$	-0.002	-0.003	$Dividend\_policy$	-0.023	-0.028
	(-0.09)	(-0.13)		(-0.54)	(-0.72)
Tax_save	0.214***	0.213***	$Exploration$	0.186	0.522
	(4.90)	(4.86)		(0.14)	(0.43)
CEO_CS	0.082**	0.096**	$Cash\_cost$	-0.001	-0.001
	(2.16)	(2.49)		(-0.27)	(-0.93)
$\%\_inst$	-0.604***	-0.615***	$\%\_blockholders$	0.183	0.290
	(-4.13)	(-4.2)		(0.56)	(0.98)
CEO_age	0.001	0.001	$\%\_inst$	-0.741**	-0.742***
	(0.56)	(0.57)		(-2.34)	(-2.6)
US_dummy	-0.393	-0.377	CEO_age	-0.001	0.010**
	(-1.48)	(-1.42)		(-0.16)	(2.35)
Gov_index_audit	0.043***	0.043***	CEO_tenure	0.008	0.007
	(3.19)	(3.2)		(1.18)	(1.12)
Gov_index_board	0.021**	0.021**	CEO_change	0.086*	0.311***
	(2.11)	(2.1)		(1.66)	(6.64)
$Gold\_price$	-0.001	-0.001	US_dummy	-0.871**	-0.915***
	(-1.16)	(-1.28)		(-2.16)	(-2.53)
$Intercept$	-0.173	-0.008	Gov_index_audit	-0.097***	-0.062***
	(-0.75)	(-0.40)		(-3.51)	(-2.49)
			Gov_index_board	-0.051***	-0.047***
				(-2.82)	(-2.95)
			$Gold\_price$	0.006***	0.006***
				(10.9)	(12.56)
			$Intercept$	0.111	1.089***
				(0.35)	(3.32)
Chi-2 (p-value)	2575.18 (0.00)	2575.35 (0.00)		1234.71 (0.00)	1599.26 (0.00)
$Observations$	342	342		342	342

Table 13: Officers' option moneyness.

This table reports the number of options granted to officers and statistics on their moneyness. Here, ITM stands for in the money, ATM for at the money, and OTM for out of the money. Columns 2 to 4 report the percentage of options relative to the universe of options granted to officers, the sample mean, and the sample standard deviation.

	Number	Percentage	Sample Mean	Sample S. Dev.
Observations with option holdings	114	100	-1.78	3.95
ITM options	30	26.32	1.63	2.20
ATM options	9	7.89	0.00	0.00
OTM options	75	65.79	-3.37	3.77

Figure 1: Sample constitution procedure.

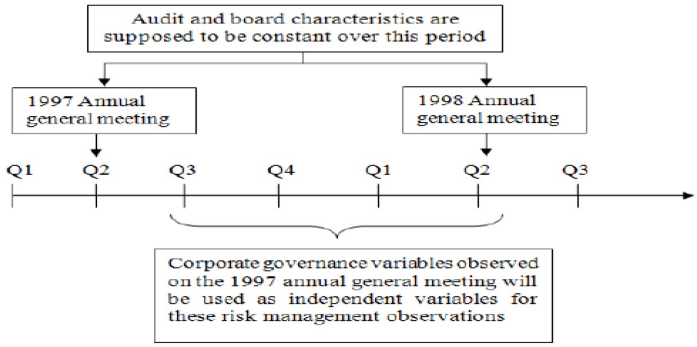


Figure 2: Observed hedge ratio.

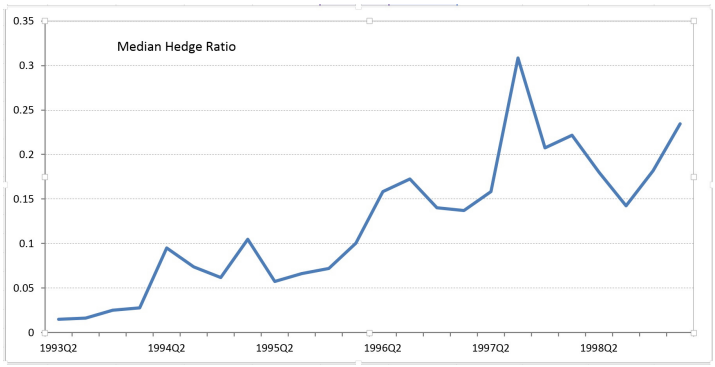
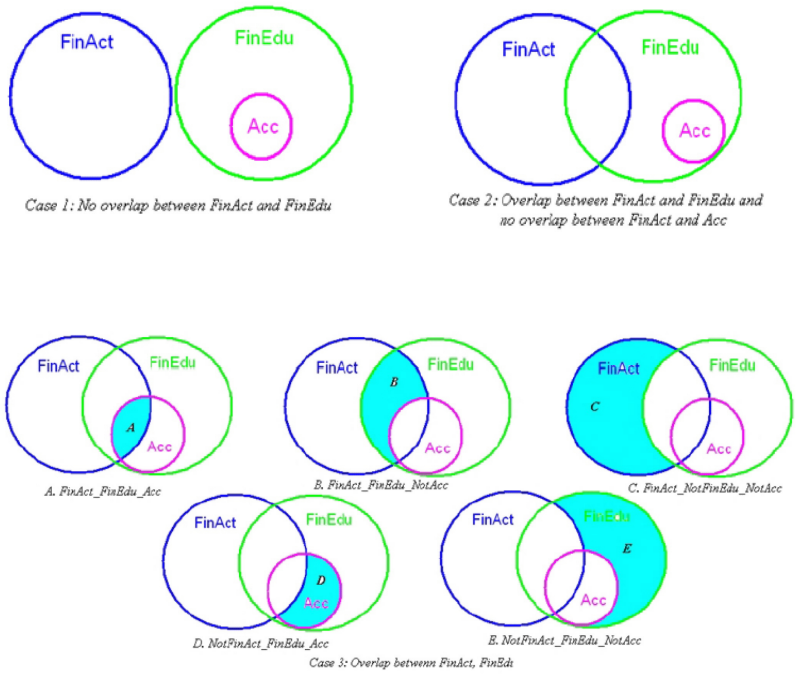


Figure 3: Categories of the financial literacy of directors.



On-line Appendix for The Governance of Risk Management: The importance of Directors Independence and Financial Knowledge

For on-line publication

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Appendix A: Variable definition

Variable name	Variable definition
Panel A : General characteristics of the firm and the market	
$Hedge\_ratio$	is the delta of the risk management portfolio held by the firm divided by its expected production. The variable is measured at the quarter end.
$Ln(size)$	is the market value of assets defined as (the number of common shares outstanding multiplied by the end-of-year price per share) plus the book value of assets minus the book value of equity. We use the logarithm of the firm size.
$Market\_to\_book$	is the market value of total assets divided by the book value of assets.
$Leverage$	is the total debt divided by the total of common equity plus preferred stocks.
$Quick\_ratio$	is the value of the cash on hand, short term investments and clients' accounts divided by the short term liabilities.
$Dividend\_policy$	is a dummy variable equal to one if a firm pays cash dividends, and zero otherwise.
Tax_save	is the expected percentage savings in tax arising from a 5% drop in the volatility of taxable income (more details in Appendix B). The computation is based on annual data. To obtain quarterly data, we assume the same value of tax advantages during the four quarters of the year.
US_dummy	is a dummy variable equal to one if the firm is a US firm, and zero otherwise.
$\%\_inst$	is the percentage of shares held by institutions.
$\%\_blockholders$	is the percentage of shares held by blockholders (i.e. a non managerial shareholder holding more than 10% of the firm's shares, Tufano (1996)).
$Exploration$	is the firm exploration expenditures scaled the firm market value.
$Cash\_\cos t$	is the operating cost of producing one ounce of gold, excluding all non-cash items such as depreciation, amortization and other financial costs.
$Gold\_price$	is the price of one ounce of gold in the spot market.
Panel B : General characteristics of directors and CEOs	
CEO_age	is the age of the CEO (years).
CEO_tenure	is a dummy variable equal to one if the CEO is tenure as CEO, and zero otherwise.
CEO_COB	is a dummy variable equal to one if the CEO is the chairman of the board, and zero otherwise.
CEO_change	is a dummy variable equal to one if the CEO changed during the year, and zero otherwise.
CEO_CS	is the net value of the common shares of the firm held by the CEO (millions, USD).
$ValCEO\_op$	is the value of exercisable options held by the CEO (millions, USD).
$ValAll\_op$	is the value of exercisable options held by all directors (millions, USD).
$Cash\_fee\_outsiders$	is the cash fee paid for each meeting to outside directors (thousands, USD).
$Annual\_fixed\_fee$	is the annual fixed fee paid for each meeting to outside directors (thousands, USD).
$CEO\_Bachelor$	is a dummy variable equal to one if the CEO has a bachelor degree in finance and zero otherwise.
CEO_High_Edu	is a dummy variable equal to one if the CEO has a Master degree or a PhD in finance and zero otherwise.

Appendix A (Continued)

Variable name	Variable definition
Panel C : Characteristics and financial background of directors	
Min_size	is a dummy variable equal to one if there is a minimum of three directors sitting on the audit committee, and zero otherwise.
Tot_indep	is a dummy variable equal to one if all directors sitting on the audit committee are unrelated directors, and zero otherwise.
Maj_indep	is a dummy variable equal to one if the majority of directors sitting on the board are unrelated, and zero otherwise.
$\%\_indep$	is the proportion of unrelated directors sitting on the board. We divide the number of unrelated directors by the size of the board.
i_Fin_know	is a dummy variable equal to one if at least one (i=One) or all (i=All) director sitting on the audit committee are financially literate, and zero otherwise.
$i\_Act\_Edu\_Acc$	is a dummy variable equal to one if i director(s) sitting on the audit committee or the board are financially active, educated, and have an accounting background, and zero otherwise.
$i\_Act\_Edu\_NotAcc$	is a dummy variable equal to one if i director(s) sitting on the audit committee or the board are financially active, educated, and do not have an accounting background, and zero otherwise.
$i\_Act\_NotEdu\_NotAcc$	is a dummy variable equal to one if i director(s) sitting on the audit committee or the board are financially active, but are not financially educated, and do not have an accounting background, and zero otherwise.
$i\_NotAct\_Edu\_Acc$	is a dummy variable equal to one if i director(s) sitting on the audit committee or the board are not financially active, but are educated, and have an accounting background, and zero otherwise.
$i\_NotAct\_Edu\_NotAcc$	is a dummy variable equal to one if i director(s) sitting on the audit committee or the board are educated, but are not financially active, and do not have an accounting background, and zero otherwise.
$\%\_Bachelor$	is the percentage of directors sitting on the board or the audit committee with a Bachelor degree.
$\%\_High\_Edu$	is the percentage of directors sitting on the board or the audit committee with a Master or a PhD degree. The percentage is relative to the size of the committee.
Num_High_Edu	is the number of directors sitting on the board or the audit committee with a Master or a PhD degree.
i_Acc	is a dummy variable equal to one if i director(s) sitting on the board or the audit committee have an accounting background, and zero otherwise.

*i=One, when we consider at least one director and i=%, when we consider the percentage of directors.

Appendix B. Details on the construction of Tax_save variable

To construct the variable measuring the tax advantage, we use the simulation approach introduced by Graham and Smith (1999).[1] However, we consider the legislation and the tax code of the country origin when calculating the level of the tax liability for each firm rather than applying the American law to all firms as in Graham and Smith (1999).

By hedging, a firm locks on the value of taxable earnings, thus reducing the volatility of the pre-tax value of assets. This in turn increases the after-tax value of assets and generates tax savings. The benefits of hedging increase with the convexity of the tax function. Following Graham and Smith (1999), we calculate the tax savings resulting from a reduction of 5% in the volatility of taxable earnings. More specifically, the expected value of taxable earnings (Π_{t+1}) follows a random walk process:

$$\Pi_{t+1} = \mu_t + \Pi_t + \varepsilon_{it}. \tag{1}$$

where ε_{it} is the tax innovation for firm i and is normally distributed. We calculate historical taxable earnings using annual data from Compustat. During our sample period, the American legislation allows firms to carry back net operating losses for 3 years and forward for 15 years while the Canadian legislation allows firms to carry back net operating losses for 3 years and forward for only 7 years. Following the procedure in Graham and Smith (1999), and with respect to the country tax plan, we calculate the tax save variable (tax_save) as the difference between the tax liability before and after a reduction of 5% in the volatility of taxable earnings. We perform this procedure 1000 times for each firm in each year. We then scale the tax variable by the value of sales during the year as in Graham and Rogers (2002).

Appendix C: Data sources

We hand collect the information on directors education and background using various sources that we may classify into two categories:

C.1 Publications

- The international who's who,
- The Canadian who's who,
- Who's who in America,
- The S&P register of corporations, directors and executives,

[1] We are grateful to John Graham for his helpful comments and suggestions in the construction of this variable.

- Who's who in Canada,
- Who's who in America,
- Who's who in Canadian business,
- Who's who in finance,
- The Northern Miner,
- Who's who in finance and industry,
- The Financial Post directory of directors,
- Who's who in Canadian finance,
- The blue book of Canadian businesses,
- Who's who in Ontario,
- Encyclopedia of British Columbia,
- Who's who in British Columbia,
- Who's who in Australia,
- Who's who in the West,
- Who's who in the South and Southwest.

C.2 Electronic sources

- Firms websites available in the internet and google search engine,
- Proquest ABI/Inform,
- Factiva provided by Reuters,
- EDGAR online,
- Lexis-Nexis,
- EUREKA.CC.
- A.CC.

Appendix D. Summary statistics: directors background

We defined three main categories of the financial background of directors sitting on the board or on the audit committee. Specifically, we count directors who are i) financially active, ii) financially educated, and/or iii) accountant. Because there may be an overlap in the definition of each category, we construct additional sub-categories which we summarize in Table D-1. Specifically, we count the number of directors who are i) financially active, and financially educated, and accountant, or ii) financially active, and financially educated, and not accountant, or iii) financially active, and not financially educated, and not accountant, or iv) not financially active, and financially educated, and accountant, or ii) not financially active, and financially educated, and not accountant. Table D-2 reports the distribution of the above variables.

Table D-1 : Statistics about variables in the sub-categories of the definition of financial literacy of directors.

We present summary statistics for the five sub-categories defining the financial literacy of the directors. The variable $FinAct\_Edu\_Acc$ counts the number of directors who are financially active, and financially educated, and accountants; $FinAct\_Edu\_NotAcc$ counts the number of directors who are financially active, and financially educated, but not accountants; $FinAct\_NotEdu\_NotAcc$ counts the number of directors who are financially active, but not financially educated, and not accountants; $NotFinAct\_Edu\_Acc$ counts the number of directors who are not financially active, but are financially educated, and accountants; $NotFinAct\_Edu\_NotAcc$ counts the number of directors who are not financially active, and are financially educated, but not accountants.

Variables	Number	Mean	Median	Std. Dev.	Min	Max
Panel A: Directors sitting on the audit committee						
Act_Edu_Acc	348	0.39	0	0.62	0	2
Act_Edu_NotAcc	348	0.31	0	0.59	0	2
Act_NotEdu_NotAcc	348	0.47	0	0.60	0	2
$NotAct\_Edu\_Acc$	348	0.21	0	0.41	0	1
$NotAct\_Edu\_NotAcc$	348	0.50	0	0.70	0	3
Panel B: Directors sitting on the board						
Act_Edu_Acc	348	0.76	1	0.79	0	3
Act_Edu_NotAcc	348	0.70	1	0.78	0	3
Act_NotEdu_NotAcc	348	1.03	1	1.03	0	4
$NotAct\_Edu\_Acc$	348	0.49	0	0.61	0	2
$NotAct\_Edu\_NotAcc$	348	1.09	1	1.17	0	5

Table D-2 : Distribution of variables in the sub-categories of the of financial literacy of directors.

We count the number of directors sitting on the board and the audit committee by sub-category of financial background. The variable $FinAct\_Edu\_Acc$ counts the number of directors who are financially active, and financially educated, and accountants; $FinAct\_Edu\_NotAcc$ counts the number of directors who are financially active, and financially educated, but not accountants; $FinAct\_NotEdu\_NotAcc$ counts the number of directors who are financially active, but not financially educated, and not accountants; $NotFinAct\_Edu\_Acc$ counts the number of directors who are not financially active, but are financially educated, and accountants; $NotFinAct\_Edu\_NotAcc$ counts the number of directors who are not financially active, and are financially educated, but not accountants.

	Members of the audit				Members of the board			
	Nb.	Freq.	Percent	Cum.	Nb.	Freq.	Percent	Cum.
Act_Edu_Acc.	0	238	68.39	68.39	0	152	43.68	43.68
	1	84	24.14	92.53	1	133	38.22	81.90
	2	26	7.47	100.00	2	56	16.09	97.99
					3	7	2.01	100.00
Act_Edu_NotAcc	0	265	76.15	76.15	0	165	47.41	47.41
	1	59	16.95	93.10	1	131	37.64	85.06
	2	24	6.90	100.00	2	44	12.64	97.70
					3	8	2.30	100.00
Act_NotEdu_NotAcc	0	202	58.05	58.05	0	136	39.08	39.08
	1	127	36.49	94.54	1	105	30.17	69.25
	2	19	5.46	100.00	2	72	20.69	89.94
					3	31	8.91	98.85
					4	4	1.15	100
NotAct_Edu_Acc	0	273	78.45	78.45	0	197	56.61	56.61
	1	75	21.55	100.00	1	130	37.36	93.97
					2	21	6.03	100
NotAct_Edu_NotAcc	0	211	60.63	60.63	0	138	39.66	39.66
	1	104	29.89	90.52	1	103	29.60	69.25
	2	29	8.33	98.85	2	64	18.39	87.64
	3	4	1.15	100.00	3	32	9.20	93.97
					4	17	4.89	96.84
					6	4	1.15	100.00

1 Appendix E. Additional Results of the paper

E.1 First stage estimation of the Heckman two-stage selection model.

This table reports results of the first stage of the Heckman two-stage selection model. The first stage uses a probit regression clustered at the firm level to evaluate the decision of hedging. The dependent variable is the hedge ratio and equals to one if the firm hedges and zero otherwise. Independent variable definitions are reported in Appendix A. From first stage we estimate the Inverse Mills ratio and we use it as a regressor in the second stage to correct for sample selection bias. Regression (1) includes a dummy variable for each quarter 0 in the data. Regression (2) includes a dummy variable for each year and regression (3) includes both a dummy variable for each quarter and for each year. Dummy variables are not reported for conciseness. The t-statistics are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	Wald test for the significance of the coef in (3) Chi2 (p-value)
$Ln(size)$	0.351***	0.318**	0.321**	4.49** (0.03)
	(2.34)	(2.13)	(2.12)	
$Market\_to\_book$	-0.463**	-0.439**	-0.438**	4.85** (0.02)
	(-2.18)	(-2.21)	(-2.20)	
$Leverage$	-0.156	-0.128	-0.155	0.47 (0.49)
	(-0.73)	(-0.59)	(-0.68)	
$Quick\_ratio$	-0.050	-0.048	-0.049	0.76 (0.38)
	(-0.91)	(-0.86)	(-0.87)	
$Dividend\_policy$	0.694*	0.600*	0.634*	2.89* (0.08)
	(1.81)	(1.78)	(1.70)	
Tax_save	-0.370	-0.491	-0.496	1.15 (0.28)
	(-0.79)	(-1.07)	(-1.07)	
US_dummy	0.251	0.302	0.335	0.71 (0.39)
	(0.66)	(0.77)	(0.84)	
$Intercept$	-0.877	-1.042	-1.389	
	(-0.8)	(-0.81)	(-0.93)	
$Dummy\_quarter$	Yes	No	Yes	
$Dummy\_year$	No	Yes	Yes	
$R-squared$	0.12	0.15	0.15	
Wald $Chi2$	22.27	40.86	45.94	
$Pr > Chi2$	0.01	0.00	0.00	
$Observations$	325	325	325	

E.2 Effect of directors education background on hedging.

We report results of the effect of directors' financial education on the hedging behavior of the firm. The model represents the second stage of the Heckman two-stage selection model (results of the first stage are reported in Table E.1). The dependent variable is the intensity of hedging using derivatives. Independent variable definitions are reported in Appendix A. All regressions have firms fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A : Directors in the audit				Panel B : Directors in the board	
	i=At least one director		i=Percentage of directors		i=Percentage of directors	
	(1)	(2)	(3)	(4)	(1)	(2)
$Ln(size)$	0.031	-0.002	-0.002	-0.057	0.036	0.060
	(0.61)	(-0.04)	(-0.04)	(-1.09)	(0.66)	(1.12)
$Market\_to\_book$	-0.015	-0.008	-0.011	0.001	-0.015	-0.006
	(-0.31)	(-0.18)	(-0.23)	(0.03)	(-0.32)	(-0.12)
$Leverage$	0.116***	0.119***	0.112***	0.123***	0.104***	0.102***
	(3.70)	(3.87)	(3.24)	(3.59)	(3.21)	(3.13)
$Quick\_ratio$	-0.004	0.003	-0.004	0.002	-0.003	-0.003
	(-0.61)	(0.44)	(-0.53)	(0.31)	(-0.37)	(-0.44)
$Dividend\_policy$	-0.006	0.002	-0.027	-0.029	-0.022	-0.021
	(-0.09)	(0.03)	(-0.43)	(-0.47)	(-0.35)	(-0.34)
Tax_save	0.306***	0.319***	0.307***	0.352***	0.306***	0.335***
	(4.06)	(4.24)	(3.98)	(4.56)	(4.00)	(4.41)
CEO_CS	0.052	-0.000	0.070	0.057	0.067	0.096**
	(1.27)	(-0.01)	(1.64)	(1.31)	(1.64)	(2.31)
$ValCEO\_op$	-0.007***	-0.007***	-0.007***	-0.009***	-0.007***	-0.004
	(-3.18)	(-3.36)	(-3.11)	(-3.37)	(-2.79)	(-1.35)
$\%\_inst$	-0.871***	-0.425**	-0.883***	-0.896***	-0.573***	-0.693***
	(-4.72)	(-2.05)	(-4.42)	(-3.94)	(-3.11)	(-3.68)
CEO_age	-0.001	-0.004	-0.002	-0.001	-0.001	-0.003
	(-0.45)	(-1.17)	(-0.50)	(-0.38)	(-0.16)	(-0.67)
Min_size	0.185***	0.134***	0.170***	0.178***		
	(3.47)	(2.53)	(2.54)	(2.46)		
$Tot(Maj)\_indep\_aud(bor)$	0.120***	-0.048	0.139***	0.018	-0.005	-0.189
	(2.56)	(-0.84)	(2.87)	(0.28)	(-0.10)	(-1.53)
$i\_Act\_Edu\_Acc$	-0.078**	-0.130***	-0.222**	-0.611***	0.000	0.537
	(-2.26)	(-3.09)	(-2.01)	(-3.99)	(0.00)	(1.05)
$i\_Act\_Edu\_Acc$		0.182***		0.598***		-0.739
$\times Tot(Maj)\_indep\_aud(bor)$		(3.14)		(3.60)		(-1.40)
$i\_Act\_Edu\_NotAcc$	-0.006	0.011	-0.055	0.018	1.049***	0.300
	(-0.17)	(0.26)	(-0.61)	(0.16)	(2.73)	(0.39)
$i\_Act\_Edu\_NotAcc$		-0.013		-0.413		1.227*
$\times Tot(Maj)\_indep\_aud(bor)$		(-0.17)		(-1.49)		(1.67)
$i\_NotAct\_Edu\_Acc$	-0.029	-0.063	-0.059	-0.442***	0.525**	1.511***
	(-0.85)	(-1.54)	(-0.57)	(-3.02)	(2.08)	(2.49)
$i\_NotAct\_Edu\_Acc$		0.075		0.542***		-0.730
$\times Tot(Maj)\_indep\_aud(bor)$		(1.18)		(2.47)		(-1.10)
$i\_NotAct\_Edu\_NotAcc$	-0.134***	-0.255***	-0.201*	-0.526***	0.119	-0.659
	(-3.41)	(-4.92)	(-1.73)	(-3.59)	(0.52)	(-1.37)
$i\_NotAct\_Edu\_NotAcc$		0.217***		0.254		1.004**
$\times Tot(Maj)\_indep\_aud(bor)$		(3.14)		(1.13)		(2.09)
$Inverse\ Mills$	-0.068	-0.043	-0.110	-0.086	0.008	0.028
	(-0.25)	(-0.16)	(-0.40)	(-0.32)	(0.11)	(0.34)
$Intercept$	-0.010	0.443	0.207	0.626	0.269	0.169
	(-0.03)	(1.13)	(0.49)	(1.50)	(0.69)	(0.40)
$R-squared$	0.31	0.37	0.28	0.35	0.26	0.30
$F-value$	5.30	5.77	4.59	5.18	0.00	0.00
$Pr > F$	0.00	0.00	0.00	0.00	4.48	4.46
$Observations$	290	290	288	288	290	290

E.3 Effect of governance indexes on hedging activities

We report results of the effect of having qualified directors sitting on the board and the audit committee on the hedging behavior of the firm. The model represents the second stage of the Heckman two-stage selection model (results of the first stage are reported in Table E.1). The dependent variable is the intensity of hedging using derivatives. The quality of the board and the audit committee are measured, respectively, by the variables gov_index_board and gov_index_audit detailed in Appendix E.2. Other independent variable definitions are reported in Appendix A. All regressions have firms fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are

into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Panel A: Multivariate regression			Panel B: Heckman second stage regression		
	(1)	(2)	(3)	(1)	(2)	(3)
$Ln(size)$	0.122***	0.134***	0.123***	0.009	0.043	0.010
	(2.99)	(3.30)	(3.05)	(0.17)	(0.86)	(0.19)
$Market-to-book$	-0.052***	-0.051***	-0.051***	-0.002	-0.030	-0.004
	(-2.79)	(-2.70)	(-2.75)	(-0.05)	(-0.64)	(-0.08)
$Leverage$	0.100***	0.110***	0.101***	0.112***	0.112***	0.113***
	(3.68)	(4.04)	(3.72)	(3.86)	(3.81)	(3.91)
$Quick\_ratio$	-0.005	-0.008	-0.006	0.001	-0.005	<0.000
	(-0.97)	(-1.47)	(-1.00)	(0.09)	(-0.78)	(-0.02)
$Dividend\_policy$	0.004	-0.003	0.000	-0.053	-0.023	-0.052
	(0.16)	(-0.10)	(0.02)	(-0.85)	(-0.37)	(-0.85)
Tax_save	0.178***	0.198***	0.190***	0.322***	0.291***	0.333***
	(3.74)	(4.10)	(3.97)	(4.29)	(3.88)	(4.46)
CEO_CS	0.089**	0.099***	0.098***	0.086**	0.096***	0.096**
	(2.15)	(2.35)	(2.36)	(2.20)	(2.43)	(2.46)
$ValCEO\_op$	-0.007***	-0.008***	-0.008***	-0.007***	-0.008***	-0.008***
	(-3.15)	(-3.49)	(-3.54)	(-3.41)	(-3.74)	(-3.89)
$\%\_inst$	-0.590***	-0.678***	-0.597***	-0.525***	-0.634***	-0.541***
	(-3.69)	(-4.29)	(-3.75)	(-2.89)	(-3.50)	(-3.00)
CEO_age	<0.000	0.002	0.002	-0.001	0.001	0.000
	(0.18)	(0.80)	(0.64)	(-0.17)	(0.18)	(0.09)
Gov_index_audit	0.043***		0.041***	0.053***		0.051***
	(2.95)		(2.83)	(3.31)		(3.21)
Gov_index_board		0.023**	0.021*		0.025***	0.023**
		(2.11)	(1.94)		(2.40)	(2.27)
$Inverse\ Mills$				-0.285	-0.098	-0.259
				(-1.06)	(-0.37)	(-0.97)
$Intercept$	-0.725***	-0.786***	-0.834***	0.065	-0.110	-0.037
	(-2.54)	(-2.69)	(-2.88)	(0.17)	(-0.29)	(-0.10)
$R-squared$	0.22	0.21	0.23	0.26	0.24	0.27
$F-value$	5.78	5.40	5.70	5.59	5.15	5.66
$Pr>F$	0.00	0.00	0.00	0.00	0.00	0.00
$Observations$	342	342	342	290	290	290

E.4 Firm performance and the predicted level of risk management

E-4.1 Effect of the quality of directors

We report results on the relation between the predicted hedging behavior and the firm performance. The first stage, in Panel A, uses the hedge ratio equation to estimate the predicted level of hedging. Panel B reports summary statistics of this predicted value. The second stage, in Panel C, evaluates the effect of the predicted level of hedging on the firm accounting performance as measured by the Return On Equity (ROE), and the Return On Assets (ROA); and the firm market performance as measure by the Tobin's Q (Tobin's Q) and the Market-to-Book (MB). Independent variable definitions are reported in Appendix A. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: First stage: the dependent variable is the hedge ratio

$Ln(size)$	0.097***
	(2.45)
$Leverage$	0.081***
	(2.72)
$Quick\_ratio$	-0.005
	(-0.93)
$Dividend\_policy$	-0.010
	(-0.36)
Tax_save	0.196***
	(4.08)
CEO_CS	0.097***
	(2.32)
$ValCEO\_op$	-0.007***
	(-3.01)
$\%\_inst$	-0.603***
	(-3.78)
CEO_age	0.001
	(0.52)
Gov_index_audit	0.045***
	(3.06)
Gov_index_board	0.017
	(1.57)
US_dummy	2.064***
	(2.62)
$Gold\_price$	-0.001***
	(-2.39)
$Intercept$	-2.303***
	(-2.85)
Chi-2 (p-value)	1126.53 (0.00)
$Observations$	342

Panel B: Summary statistics for the predicted hedge ratio

$Mean$	0.26
$Median$	0.16
$Standard\ deviation$	0.27
$Observations$	342

Panel C: Second stage: the dependent variable is the firm performance

	ROE	ROA	Tobin's Q	MB
$Hedge\_ratio\_predicted$	0.573**	0.184**	0.945***	0.907***
	(2.02)	(2.01)	(2.38)	(2.34)
$Ln(size)$	-0.064	-0.039*	0.316***	0.336***
	(-0.82)	(-1.66)	(3.21)	(3.49)
$Market\_to\_book$	-0.051	-0.011		
	(-1.25)	(-0.81)		
$Leverage$	-0.123**	-0.074***	0.089	0.102
	(-2.16)	(-4.35)	(1.23)	(1.45)
$Quick\_ratio$	-0.008	0.000	-0.006	-0.007
	(-0.82)	(0.07)	(-0.40)	(-0.53)
$Dividend\_policy$	-0.024	0.000	0.117	0.089
	(-0.50)	(-0.03)	(1.61)	(1.26)
$Exploration$	1.613	-1.676***	0.386	0.063
	(1.05)	(-3.25)	(0.17)	(0.03)
$Cash\_cost$	-0.001	-0.001	-0.002***	-0.002***
	(-1.49)	(-1.10)	(-3.75)	(-3.38)
$\%\_inst$	-0.211	0.028	-1.437***	-1.466***
	(-0.59)	(0.25)	(-2.94)	(-3.07)
$\%\_bockholders$	0.544	0.116	3.309***	3.404***
	(1.52)	(0.97)	(6.80)	(7.16)
Maj_unr	-0.048	-0.002	-0.137	-0.160
	(-0.66)	(-0.08)	(-1.31)	(-1.57)
CEO_age	-0.007	-0.002	-0.004	-0.003
	(-1.33)	(-1.11)	(-0.46)	(-0.45)
CEO_COB	0.013	0.016	-0.128	-0.131
	(0.16)	(0.62)	(-1.10)	(-1.15)
CEO_tenure	0.013	0.003	0.020	0.017
	(1.34)	(0.93)	(1.45)	(1.26)
CEO_change	-0.020	-0.005	-0.169*	-0.181*
	(-0.29)	(-0.25)	(-1.78)	(-1.95)
US_dummy	-0.471	-0.055	-2.736***	-2.877***
	(-1.31)	(-0.48)	(-5.71)	(-6.14)
$Gold\_price$	0.002***	<0.000	0.010***	0.010***
	(2.45)	(1.42)	(11.38)	(11.33)
$Intercept$	0.525	0.281*	-3.221***	-3.206***
	(0.99)	(1.74)	(-4.82)	(-4.91)
Chi-2 (p-value)	136.48 (0.00)	101.79 (0.00)	1745.59 (0.00)	1725.17 (0.00)
$Observations$	339	341	341	342

E-4.2 Effects of SOX and NYSE regulations

We report results on the relation between the predicted hedging behavior and the firm performance. The first stage, in Panel A, uses the hedge ratio equation to estimate the predicted level of hedging. Panel B reports summary statistics of this predicted value. The second stage, in Panel C, evaluates the effect of the predicted level of hedging on the firm accounting performances as measured by the Return On Equity (ROE), and the Return On Assets (ROA); and the firm market performance as measure by the Tobin's Q (Tobin's Q) and the Market-to-Book (MB). Independent variable definitions are reported in Appendix A. All regressions have firm fixed effects and include a dummy variable for each quarter to control for seasonal effects in the data. The t-statistics are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: First stage: the dependent variable is the hedge ratio

$Ln(size)$	0.074*
	(1.80)
$Leverage$	0.075***
	(2.50)
$Quick\_ratio$	-0.005
	(-0.85)
$Dividend\_policy$	-0.007
	(-0.26)
Tax_save	0.196***
	(4.07)
CEO_CS	0.076*
	(1.79)
$ValCEO\_op$	-0.007***
	(-2.85)
$\%\_inst$	-0.734***
	(-4.57)
CEO_age	0.000
	(-0.10)
US_Dummy	1.640**
	(2.06)
$Compliance\_SOX1$	0.103**
	(2.31)
$Compliance\_NYSE1$	-0.025
	(-1.35)
$Gold\_Price$	<0.001
	(-0.99)
$Intercept$	-1.752**
	(-2.17)
Adj R-squared	0.21
Chi-2 (p-value)	1105.14 (0.00)
$Observations$	342

Panel B: Summary statistics for the predicted hedge ratio

$Median$	0.15
$Standard\ deviation$	0.27
$Observations$	342
$Observations$	342

Panel C: Second stage: the dependent variable is the firm performance

	ROE	ROA	Tobin's Q	MB
$Hedge\_ratio\_predicted$	0.279	0.088	0.738*	0.732*
	(0.89)	(0.90)	(1.74)	(1.77)
$Ln(size)$	-0.035	-0.032	0.334***	0.351***
	(-0.44)	(-1.34)	(3.36)	(3.62)
$Market\_to\_book$	-0.044	-0.009		
	(-1.09)	(-0.63)		
$Leverage$	-0.105*	-0.070***	0.097	0.109
	(-1.78)	(-4.04)	(1.32)	(1.52)
$Quick\_ratio$	-0.009	0.000	-0.006	-0.008
	(-0.92)	(-0.02)	(-0.42)	(-0.54)
$Dividend\_policy$	-0.022	0.000	0.119	0.090
	(-0.45)	(0.01)	(1.64)	(1.27)
$Exploration$	1.741	-1.640***	0.540	0.207
	(1.12)	(-3.17)	(0.24)	(0.09)
$Cash\_cost$	0.000	0.000	-0.002***	-0.002***
	(-1.23)	(-0.83)	(-3.62)	(-3.26)
$\%\_Inst$	-0.300	0.006	-1.486***	-1.506***
	(-0.82)	(0.05)	(-3.01)	(-3.12)
$\%\_Bockholders$	0.426	0.077	3.199***	3.303***
	(1.20)	(0.65)	(6.61)	(6.99)
Maj_Indep_Bor	-0.031	0.005	-0.088	-0.111
	(-0.40)	(0.21)	(-0.83)	(-1.07)
CEO_Age	-0.008	-0.002	-0.003	-0.003
	(-1.33)	(-1.05)	(-0.40)	(-0.39)
CEO_COB	0.007	0.016	-0.144	-0.147
	(0.08)	(0.59)	(-1.22)	(-1.27)
CEO_Tenure	0.014	0.003	0.022	0.019
	(1.46)	(1.00)	(1.60)	(1.41)
CEO_Change	-0.011	-0.001	-0.154	-0.167*
	(-0.16)	(-0.05)	(-1.62)	(-1.80)
US_Dummy	-0.368	-0.028	-2.645***	-2.792***
	(-1.03)	(-0.24)	(-5.52)	(-5.97)
$Gold\_Price$	0.001**	0.001	0.010***	0.010***
	(2.04)	(0.99)	(10.98)	(10.97)
$Intercept$	0.440	0.270*	-3.293***	-3.275***
	(0.82)	(1.66)	(-4.91)	(-5.00)
Chi-2 (p-value)	131.73	97.47	1727.55	1709.41
$Observations$	339	341	341	342

E.5 The importance of education

We report results of the regression of the hedge ratio on the level of education of directors. In Panel A, we account for the education of directors sitting on the audit committee. In Panel B and Panel C, we account respectively for the education of directors sitting on the board and the CEO. All independent variable definitions are reported in Appendix A (Table A-1). All regressions have firms fixed effects and includes a dummy variable for each quarter (not reported for conciseness) to control for seasonal effects in the data. The $t-statistics$ are into parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A : Education of members of the audit	(1)	(2)	(3)	(4)	(5)
$Ln(size)$	0.042	0.045	0.016	-0.014	0.038
	(0.82)	(0.89)	(0.31)	(-0.26)	(0.77)
$Market\_to\_book$	-0.024	-0.019	-0.011	-0.005	-0.031
	(-0.52)	(-0.41)	(-0.25)	(-0.10)	(-0.68)
$Leverage$	0.109***	0.107***	0.106***	0.098***	0.095***
	(3.59)	(3.45)	(3.38)	(2.93)	(3.11)
$Quick\_ratio$	-0.008	-0.009	-0.004	-0.001	-0.010
	(-1.20)	(-1.31)	(-0.52)	(-0.21)	(-1.51)
$Dividend\_policy$	0.007	0.001	-0.003	-0.024	0.003
	(0.12)	(0.01)	(-0.05)	(-0.40)	(0.05)
Tax_save	0.300***	0.309***	0.307***	0.308***	0.325***
	(4.18)	(4.33)	(4.21)	(4.10)	(4.44)
CEO_CS	0.078**	0.080**	0.076*	0.082**	0.052
	(2.02)	(2.08)	(1.94)	(2.09)	(1.29)
$ValCEO\_op$	-0.008***	-0.008***	-0.008***	-0.008***	-0.010***
	(-3.93)	(-4.03)	(-3.81)	(-3.52)	(-4.50)
$\%\_inst$	-0.930***	-0.960***	-0.895***	-0.825***	-1.183***
	(-4.87)	(-5.05)	(-4.91)	(-4.34)	(-6.17)
CEO_age	-0.003	-0.003	-0.005	-0.003	-0.004
	(-1.10)	(-0.93)	(-1.43)	(-0.99)	(-1.25)
Min_size	0.121**	0.126**	0.172***	0.164***	0.132***
	(2.14)	(2.21)	(3.19)	(2.83)	(2.45)
Tot_indep	0.089*	0.095**	0.120***	0.139***	0.104**
	(1.85)	(2.03)	(2.55)	(2.89)	(2.27)
$\%\_Bachelor$	-0.171***	-0.181***			
	(-2.85)	(-3.09)			
$\%\_High\_Edu$			-0.194*	-0.15559	-0.523***
			(-1.89)	(-1.48)	(-3.90)
$One\_NotAct\_Edu\_NotAcc$	-0.235***		-0.193***		-0.148***
	(-4.51)		(-4.21)		(-3.08)
$One\_NotAct\_Edu\_NotAcc \times \%\_bachelor$	0.310***				
	(3.01)				
$One\_NotAct\_Edu\_NotAcc \times \%\_High\_Edu.$			0.396***		0.983***
			(2.43)		(3.97)
$\%\_NotAct\_Edu\_NotAcc$		-0.831***		-0.258*	
		(-4.24)		(-1.95)	
$\%\_NotAct\_Edu\_NotAcc \times \%\_bachelor$		0.956***			
		(4.85)			
$\%\_NotAct\_Edu\_NotAcc \times \%\_High\_Edu$				0.814**	
				(1.99)	
$One\_NotAct\_Edu\_Acc$					-0.204***
					(-4.57)
$One\_NotAct\_Edu\_Acc \times \%\_High\_Edu$					0.347**
					(2.18)
$Inverse\ Mills$	0.002	0.001	-0.055	-0.110	-0.001
	(0.01)	(0.00)	(-0.21)	(-0.41)	(-0.00)
$Intercept$	0.093	0.044	0.234	0.318	0.252
	(0.24)	(0.11)	(0.60)	(0.79)	(0.66)
$R-squared$	0.33	0.34	0.32	0.28	0.36
$F-value$	6.13	6.38	5.76	4.84	6.27
$\Pr > F$	0.00	0.01	0.02	0.03	0.04
$Observations$	288	288	288	288	288

Table E-5 (Continued)

	(1)	(2)	(3)	(4)	(1)	(2)
	Panel B: Education of members of the board				Panel C : Education of the CEO	
$Ln(size)$	0.055	0.056	0.042	0.039	0.048	0.040
	(1.09)	(1.16)	(0.86)	(0.80)	(0.94)	(0.81)
$Market\_to\_book$	-0.020	-0.039	-0.026	-0.030	-0.032	-0.022
	(-0.42)	(-0.87)	(-0.59)	(-0.66)	(-0.68)	(-0.49)
$Leverage$	0.118***	0.102***	0.104***	0.086***	0.116***	0.124***
	(4.01)	(3.60)	(3.57)	(2.94)	(3.87)	(4.30)
$Quick\_ratio$	-0.001	-0.005	-0.003	-0.003	-0.004	-0.007
	(-0.16)	(-0.70)	(-0.48)	(-0.39)	(-0.65)	(-1.01)
$Dividend\_policy$	-0.040	0.001	-0.009	-0.010	-0.024	-0.032
	(-0.64)	(0.02)	(-0.15)	(-0.17)	(-0.37)	(-0.53)
Tax_save	0.315***	0.344***	0.373***	0.379***	0.276***	0.335***
	(4.15)	(4.73)	(5.07)	(5.11)	(3.63)	(4.51)
CEO_CS	0.086**	0.083**	0.084**	0.083**	0.097***	0.092***
	(2.16)	(2.16)	(2.21)	(2.17)	(2.37)	(2.36)
$ValCEO\_op$	-0.007***	-0.007***	-0.008***	-0.007***	-0.005**	-0.006***
	(-2.85)	(-2.97)	(-3.32)	(-2.93)	(-2.22)	(-2.44)
$\%\_inst$	-0.557***	-0.535***	-0.554***	-0.517***	-0.615***	-0.651***
	(-3.03)	(-3.05)	(-3.18)	(-2.96)	(-3.32)	(-3.66)
CEO_age	-0.002	-0.001	-0.001	-0.001	-0.003	-0.001
	(-0.55)	(-0.03)	(-0.24)	(-0.17)	(-0.69)	(-0.30)
Maj_indep_aud	-0.029	-0.021	-0.004	-0.012	-0.064	-0.046
	(-0.60)	(-0.45)	(-0.09)	(-0.24)	(-1.23)	(-0.98)
$\%\_Bachelor$	0.320***					
	(2.59)					
$\%\_High\_Edu$		1.055***	1.065***	1.142***		
		(5.25)	(5.24)	(5.09)		
$One\_NotAct\_Edu\_Acc$			0.044			
			(1.50)			
$One\_NotAct\_Edu\_Acc \times \%\_Bachelor$			0.432			
			(1.54)			
$\%\_NotAct\_Edu\_Acc$				0.416		
				(1.50)		
$\%\_NotAct\_Edu\_Acc \times \%\_High\_Edu$				1.404		
				(0.50)		
$CEO\_Bachelor$					-0.039	
					(-0.86)	
CEO_High_Edu						0.332***
						(4.26)
$Inverse\ Mills$	-0.200	-0.045	-0.083	-0.093	-0.122	-0.177
	(-0.75)	(-0.18)	(-0.32)	(-0.36)	(-0.45)	(-0.68)
$Intercept$	-0.075	-0.244	-0.188	-0.152	0.123	0.071
	(-0.19)	(-0.64)	(-0.49)	(-0.39)	(0.31)	(0.19)
$R-squared$	0.25	0.30	0.32	0.32	0.23	0.28
$F-value$	4.97	6.65	6.34	6.28	4.48	5.89
$\Pr > F$	0.00	0.01	0.02	0.03	0	0
$Observations$	290	290	290	290	290	290

Appendix F. Details on the construction of the governance indexes

F.1 Measuring governance standards

For the audit committee, we construct the following dummy variables

- A1=1 if the audit committee is entirely composed of independent directors and 0 otherwise.
- A2=1 if the audit committee contains at least three members and 0 otherwise.
- A3=1 if the average tenure in the audit committee for directors is superior to 10 years and 0 otherwise.
- A4=1 if at least 25% of the audit committee hold a Master degree or a PhD in finance and 0 otherwise.
- A5=1 if each member of the audit committee is financially literate.
- A6=1 if the majority of the audit committee is comprised of financially active directors and 0 otherwise.
- A7=1 if the majority of the audit committee is comprised of financially educated directors and 0 otherwise.
- A8=1 if the majority of the audit committee is comprised of directors with accounting background and 0 otherwise.
- A9=1 if at least one director in the audit committee is considered as financially knowledgeable and 0 otherwise.
- A10=1 if at least one director in the audit committee has an accounting background and 0 otherwise.

For the board, we construct the following variables

- B1=1 if the majority of directors in the board is independent and 0 otherwise.
- B2=1 if the CEO is the COB and 0 otherwise.
- B3=1 if the average tenure of directors in the board is superior to 10 years and 0 otherwise.
- B4=1 if at least 25% of directors in the board hold a Master or a PhD in finance and 0 otherwise.
- B5=1 if the majority of directors in the board are considered as financially knowledgeable and 0 otherwise.
- B6=1 if at least 25% of directors in the board are financially active and 0 otherwise.

- B7=1 if at least 25% of directors in the board are financially educated and 0 otherwise.
- B8=1 if at least 25% of directors in the board have an accounting background and 0 otherwise.

Many of the variables listed above are constructed to capture the different requirements of SOX and NYSE. Note that we refer to financial literacy of directors as either i) education in finance ii) accounting background, iii) experience in finance, or iv) a combination of these. Thus, we construct dummy variables (for instance, A5 and A9) to measure financial knowledge in the sense of SOX and NYSE. For our two indexes that we define below, we make a difference between different levels and types of financial literacy. Table E-1 reports summary statistics of the above dummy variables.

Table F-1: Table of frequencies
Panel A: Audit committee

Value	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
0	46.84	9.20	93.68	74.14	71.26	39.66	25.00	90.23	10.34	57.76
1	53.16	90.80	6.32	25.86	28.74	60.34	75.00	9.77	89.65	42.24

Panel B: Board

Value	B1	B2	B3	B4	B5	B6	B7	B8
0	25.29	32.47	95.4	83.62	59.20	53.45	39.37	79.60
1	74.71	67.53	4.60	16.38	40.80	46.55	60.63	20.40

F-1.1 SOX standards

We construct two compliance indexes to measure the SOX standards.

$$Compliance\_SOX1 = A1 + A9, \quad (2)$$
$$Compliance\_SOX2 = A1 \times A9. \quad (3)$$

F-1.2 NYSE standards

We also construct two compliance indexes to measure the NYSE standards as follows

$$Compliance\_NYSE1 = B1 + A2 + A5 + A10, \quad (4)$$
$$Compliance\_NYSE2 = B1 \times A2 \times A5 \times A10. \quad (5)$$

F-1.3 SOX and NYSE standards

To obtain the compliance index to both SOX and NYSE standards, we construct the following two variables

$$Compliance\_SOX1\_NYSE1 = A1 + A9 + B1 + A2 + A5 + A10, \quad (6)$$
$$Compliance\_SOX2\_NYSE2 = A1 \times A9 \times B1 \times A2 \times A5 \times A10. \quad (7)$$

Note that the indexes $Compliance\_SOX1$, $Compliance\_NYSE1$, and $Compliance\_SOX1\_NYSE1$ measure the degree of firms compliance to SOX, NYSE requirements, or both, respectively. However, the indexes $Compliance\_SOX2$, $Compliance\_NYSE2$, and $Compliance\_SOX2\_NYSE2$ are dummy variables, which take on the value of one if the firm meets all the specified requirements at the same time.

F2. Measuring the quality of the board and audit members

We extend the requirement of SOX and NYSE to construct a measure that captures the quality of the board and the audit committee. Specifically, we construct two additional indexes.

F-2.1 The quality of the audit committee

For the audit committee, our index requires the independence of directors and gives a higher score to audit committees comprising directors with different levels and types of financial knowledge.

$$Gov\_index\_audit = A1 + A2 - A3 + A4 + A5 + A6 + A7 + A8 \tag{8}$$

F-2.2 The quality of board

Similarly, we construct the following score index for the board

$$Gov\_index\_board = B1 - B2 - B3 + B4 + B5 + B6 + B7 + B8 \tag{9}$$

Appendiex G: Further Analysis

G-1 Principal component analysis on governance variables

Table G.1 : The table reports the weights of the govenance variable (A1 to A8 for the audit committee, Panel A and B1 to B8 for the board, Panle B),comprising each of the principal factors (C1 to C8). The retained first factor C1 explains 47% of the total variance of audit committee governance variables and 37% of the total variance of board governance variables.

Panel A: principal component for variables of the audit

Variable	C1	C2	C3	C4	C5	C6	C7	C8
A1	0.30	0.20	-0.39	-0.45	0.08	0.71	0.02	-0.04
A2	-0.18	0.35	0.42	0.44	0.55	0.42	0.03	-0.03
A3	0.53	-0.11	0.05	0.34	-0.09	0.10	-0.59	0.47
A4	0.22	-0.18	0.42	-0.59	0.52	-0.22	0.02	0.26
A5	0.39	-0.15	-0.44	0.27	0.54	-0.28	0.01	-0.43
A6	0.34	-0.51	0.24	0.23	-0.16	0.27	0.64	0.02
A7	0.43	0.32	0.48	-0.10	-0.30	-0.08	-0.13	-0.60
A8	0.31	0.64	-0.13	0.09	-0.04	-0.31	0.47	0.40

Panel B: principal component for variables of the board

Variable	C1	C2	C3	C4	C5	C6	C7	C8
B1	0.08	-0.43	-0.21	0.74	0.04	-0.07	0.43	0.17
B2	0.02	-0.06	0.56	-0.05	0.79	-0.06	0.16	0.14
B3	-0.51	0.48	0.00	0.07	-0.09	0.28	0.28	0.58
B4	0.53	0.14	-0.45	-0.14	0.24	-0.17	-0.23	0.58
B5	0.27	0.40	0.19	0.58	0.07	0.42	-0.44	-0.14
B6	0.23	0.42	0.37	0.16	-0.33	-0.68	0.19	0.03
B7	0.52	0.21	-0.03	-0.23	-0.05	0.43	0.64	-0.21
B8	0.24	-0.43	0.51	-0.11	-0.44	0.26	-0.13	0.45

G-2 Principal components of governance and firm performance

	ROE	ROA	Tobin's Q	MB		ROE	ROA	Tobin's Q	MB
Panel A: The hedge ration is the dependent variable					Panel B: The firm performance is the dependent variable				
$Firm\_performance$	-0.108	-0.340	-0.058	-0.050	$Hedge\_ratio$	0.647***	0.219**	0.877**	0.824**
	(-0.49)	(-0.77)	(-1.28)	(-1.13)		(2.39)	(2.28)	(2.04)	(1.96)
$Ln(size)$	0.138***	0.126***	0.149***	0.144***	$Ln(size)$	-0.088	-0.067***	0.364***	0.380***
	(3.48)	(3.03)	(3.41)	(3.34)		(-1.14)	(-2.44)	(3.17)	(3.38)
$Market\_to\_book$	-0.049***	-0.047***			$Market\_to\_book$	-0.024	<0.001		
	(-2.40)	(-2.51)				(-0.63)	(0.01)		
$Leverage$	0.094***	0.077*	0.101***	0.099***	$Leverage$	-0.133***	-0.093***	0.129	0.139*
	(2.91)	(1.87)	(3.61)	(3.57)		(-2.42)	(-4.74)	(1.54)	(1.69)
$Quick\_ratio$	-0.006	-0.005	-0.004	-0.004	$Quick\_ratio$	-0.007	<0.001	-0.006	-0.008
	(-1.09)	(-1.15)	(-0.85)	(-0.84)		(-0.8)	(0.16)	(-0.44)	(-0.57)
$Dividend\_policy$	-0.013	-0.005	-0.002	-0.003	$Dividend\_policy$	-0.026	-0.001	0.117	0.087
	(-0.44)	(-0.2)	(-0.1)	(-0.14)		(-0.55)	(-0.100)	(1.62)	(1.24)
Tax_save	0.208***	0.216***	0.178***	0.179***	$Exploration$	1.622	-1.791***	0.432	0.084
	(4.06)	(4.54)	(4.07)	(4.13)		(1.1)	(-3.47)	(0.20)	(0.04)
CEO_CS	0.112***	0.120***	0.126***	0.123***	$Cash\_cost$	<-0.001*	<-0.001	-0.002***	-0.001***
	(2.77)	(3.13)	(3.18)	(3.18)		(-1.78)	(-1.14)	(-3.81)	(-3.38)
$ValCEO\_op$	-0.007***	-0.005***	-0.006***	-0.006***	$\%\_inst$	-0.168	0.110	-1.634***	-1.640***
	(-2.90)	(-2.73)	(-3.13)	(-3.15)		(-0.49)	(0.92)	(-3.22)	(-3.30)
$\%\_inst$	-0.640***	-0.612***	-0.605***	-0.597***	$\%\_blockholders$	0.516	0.098	3.323***	3.401***
	(-3.99)	(-4.17)	(-4.07)	(-4.05)		(1.53)	(0.84)	(6.74)	(7.04)
CEO_age	0.001	0.001	0.001	0.001	Maj_unr	-0.020	0.014	-0.155	-0.178*
	(0.49)	(0.55)	(0.51)	(0.50)		(-0.28)	(0.60)	(-1.44)	(-1.71)
US_dummy	2.435***	-0.264	-0.350	-0.312	CEO_age	-0.006	<-0.001	-0.005	-0.004
	(3.19)	(-0.99)	(-1.14)	(-1.04)		(-1.21)	(-0.37)	(-0.65)	(-0.61)
PC_gov_board	0.033*	0.038***	0.041***	0.044***	$CEO = COB$	0.007	0.026	-0.172	-0.173
	(1.93)	(2.43)	(2.64)	(2.85)		(0.1)	(1.00)	(-1.49)	(-1.53)
PC_gov_audit	0.045***	0.042***	0.042***	0.041***	CEO_tenure	0.013	0.001	0.022*	0.018
	(2.82)	(3.62)	(3.60)	(3.59)		(1.48)	(0.52)	(1.63)	(1.39)
$Gold\_price$	<-0.001	<-0.001	<-0.001	<-0.001	CEO_change	0.011	0.011	-0.192**	-0.207**
	(-0.71)	(-1.37)	(-0.62)	(-0.83)		(0.18)	(0.52)	(-1.96)	(-2.16)
					US_dummy	0.277	-0.131	0.181	-3.854***
						(0.51)	(-0.85)	(0.27)	(-4.89)
					$Gold\_price$	0.001***	<0.001	0.010***	0.009***
						(2.49)	(0.99)	(11.25)	(11.13)
$Intercept$	-2.741***	-0.426	-0.551	-0.521	$Intercept$	0.231	0.337	-3.997***	-2.831***
	(-3.47)	(-1.339)	(-1.59)	(-1.531)		(0.42)	(1.63)	(-4.63)	(-3.722)
Chi2	1234.97	2606.28	2532.84	2563.08		159.07	103.07	1759.06	9070.12
P-value	(0.00)	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.00)	(0.00)
Observations	339.00	341	341	342		339	341	341	342